7

William Aspinall

ENCYCLOPÆDIA BRITANNICA;

OR, A

DICTIONARY

OF

ARTS, SCIENCES, &c.

On a PLAN entirely NEW:

BY WHICH,

THE DIFFERENT SCIENCES AND ARTS

Are digested into the FORM of Distinct

TREATISES OR SYSTEMS,

COMPREHENDING

The HISTORY, THEORY, and PRACTICE, of each,
according to the Latest Discoveries and Improvements;

AND FULL EXPLANATIONS ARE GIVEN OF THE

VARIOUS DETACHED PARTS OF KNOWLEDGE,

WHETHER RELATING TO

NATURAL and ARTIFICIAL Objects, or to Matters ECCLESIASTICAL,
CIVIL, MILITARY, COMMERCIAL, *&c.*

TOGETHER WITH

A DESCRIPTION of all the Countries, Cities, principal Mountains, Seas, Rivers, *&c.*
throughout the WORLD;

A General HISTORY, *Ancient* and *Modern*, of the different Empires, Kingdoms, and States;

AND

An Account of the LIVES of the most Eminent Persons in every Nation,
from the earliest ages down to the present times.

THE WHOLE COMPILED FROM
THE WRITINGS OF THE BEST AUTHORS, IN SEVERAL LANGUAGES; THE MOST APPROVED DICTIONARIES,
AS WELL OF GENERAL SCIENCE AS OF PARTICULAR BRANCHES; THE TRANSACTIONS, JOURNALS, AND MEMOIRS, OF LEARNED
SOCIETIES, BOTH AT HOME AND ABROAD; THE MS. LECTURES OF EMINENT PROFESSORS ON DIFFERENT SCIENCES;
AND A VARIETY OF ORIGINAL MATERIALS, FURNISHED BY AN EXTENSIVE CORRESPONDENCE.

The SECOND EDITION; greatly Improved and Enlarged.

ILLUSTRATED WITH ABOVE TWO HUNDRED COPPERPLATES.

VOL. VII.

INDOCTI DISCANT, ET AMENT MEMINISSE PERITI.

EDINBURGH:

Printed for J. BALFOUR and Co. W. GORDON, J. BELL, J. DICKSON, C. ELLIOT, W. CREECH,
J. McCLIESH, A. BELL, J. HUTTON, and C. MACFARQUHAR.

MDCCLXXXI.

A NEW

Dictionary of Arts, Sciences, &c.

MEDICINES, whatever fubftances ferve to reftore health.—Medicines are either *fimple* or *compound;* the former being prepared by nature alone; and the latter owing to the induftry of man, by varioufly mixing the fimple together. See PHARMACY.

MEDICINES are likewife diftinguifhed, from the manner of ufing them, into *external* and *internal;* and with regard to their effects, they are faid to be *emetic*, *cathartic*, *aftringent*, &c. See MATERIA MEDICA.

Pocket MEDICINES, in furgery, thofe which a furgeon ought always to carry about with him, in a box, or convenient cafe.

Thofe, according to Heifter, are the common digeftive ointment, and the brown or Egyptian ointment, for cleanfing and digefting foul ulcers; and fome vulnerary balfams, as the *linimentum Arcæi*, or the balfam of Peru, Gilead, or Copivi, or the Samaritan balfam: to thefe muft alfo be added a plafter or two; as the *diachylon* or *ftypticum Crollii*, fince one or other of thefe is almoft conftantly wanted. Neither fhould there be wanting a piece of blue vitriol for the taking down luxuriant flefh, and to ftop hæmorrhages: but if vitriol is wanting, burnt alum, red precipitate, the infernal ftone, or any other corrofive medicine, will fupply its place in corrofive intentions; and the laft will alfo ferve to open abfceffes, to make iffues, and perform many other operations of that kind.

With thefe there fhould always be kept in readinefs alfo a quantity of fcraped lint, that the furgeon may be able to give immediate affiftance to wounded perfons; fince, if he is unprepared for this, they may eafily be taken off by an hæmorrhage; a circumftance which ought alfo to prevail with him to be always provided with fuitable bandages.

MEDIETAS LINGUÆ, in law, fignifies a jury, or inqueft impanelled, of which the one half are natives of this land, and the other foreigners. This jury is never ufed except where one of the parties in a plea is a ftranger, and the other a denizen. In petit-treafon, murder, and felony, foreigners are allowed this privilege; but not in high-treafon, becaufe an alien in that cafe fhall be tried according to the rules of the common law, and not by a *medietas linguæ*. A grand jury ought not in any cafe to be of a *medietas linguæ;* and the perfon that would have the advantage of a trial in this way, is to pray the fame, otherwife it will not be permitted on a challenge of the jurors.

MEDIMNUS, in Grecian antiquity, a meafure of capacity. See MEASURE.

MEDINA-TALNARI, a famous town of Arabia Petræa, between Arabia Deferta and Arabia the Happy; celebrated for being the burial-place of Mahomet. It is feated in a plain abounding with palm-trees, in E. Long. 39. 53. N. Lat. 25. See *(Hiftory of)* ARABIA.

MEDINA-*Celi*, an ancient town of Spain, in Old Caftile, and capital of a confiderable duchy of the fame name; feated near the river Xalon, in W. Long. 2. 9. N. Lat. 41. 15.

MEDINA-*de-las-Torres*, a very ancient town of Spain, in Eftremadura, with an old caftle, and the title of a duchy. It is feated on the confines of Andalufia, at the foot of a mountain near Bajadoz.

MEDINA-*del-Campo*, a large, rich, and ancient town of Spain, in the kingdom of Leon. The great fquare is very fine, and adorned with a fuperb fountain. It is a trading place, enjoys great privileges, and is feated in a country abounding with corn and wine. W. Long. 4. 20. N. Lat. 41. 22.

MEDINA-*del-rio-Secco*, an ancient and rich town of Spain, in the kingdom of Leon, with the title of a duchy; feated on a plain, where there are fine paftures. E. Long. 4. 33. N. Lat. 42. 8.

MEDINA (Sir John), an eminent painter, was the fon of Medina de l'Afturias, a Spanifh captain, who had fettled at Bruffels; where the fon was born, and inftructed in painting by Du Chatel. He married young; and in 1686 came into England, where he drew portraits for feveral years. The earl of Leven encouraged him to go to Scotland, and procured him a fubfcription of 500l. worth of bufinefs. He painted moft of the Scotch nobility; and at Wentworth-caftle is a large piece, containing the firft duke of Argyle and his fons, the two late dukes John and Archibald, in Roman habits; the ftyle Italian, and fuperior to moft modern performers. The portraits of the profeffors in the furgeons-hall at Edinburgh were painted by him, and are commended; and in that hall are two fmall hiftory-pieces by him. He was knighted by the duke of Queenfberry, lord high-commiffioner; and was the laft knight made in Scotland before the Union. He was not, however, rich; for he had 20 children. He died in Scotland; and was buried in the church-

yard of the Gray-friars at Edinburgh in 1711, aged 52. He was capable both of hiftory and landfcape. The prints in the octavo edition of Milton were defigned by him.

MEDIOLANUM, an ancient city, the capital of the Infubres, built by the Gauls on their fettlement in that part of Italy. A *municipium*, and a place of great ftrength. The feat of the liberal arts; whence it had the name of *Novæ Athenæ*. Now *Milan*, capital of the Milanefe, fituate on the rivers Olana and Lombro, E. Long. 9. 30. N. Lat. 45. 25.

MEDIOLANUM *Aulercorum* (anc. geogr.), a town of Gallia Celtica, which afterwards took the name of the *Eburovicum Civitas* (Antonine); corrupted to *Civitas Ebroicorum*, and this laft to *Ebroica;* whence the modern appellation *Evreux*, a city of Normandy. E. Long. 1. 12. N. Lat. 49. 21.

MEDIOLANUM *Gugernorum* (anc. geogr.), a town of Gallia Belgica, now the village *Moyland*, not far from Cologne.

MEDIOLANUM *Ordovicum* (anc. geogr.), a town of Britain, now *Llan Vethlin*, a market-town in Montgomeryfhire in Wales.

MEDIOLANUM *Santonum* (anc. geogr.), which afterwards taking the name of the people, was called *Santonica Urbs;* alfo *Santones* and *Santoni:* A town of Aquitain. Now *Saintes*, capital of Saintonge in Guienne, on the river Charente. W. Long. 36. 0. N. Lat. 45. 50.

MEDITERRANEAN SEA, extends from the Straits of Gibraltar to the coaft of Syria and Paleftine, being above 2000 miles in length, but of very unequal breadth: the weft part of it feparating Europe from Africa; and the Levant, or eaft part of it, dividing Afia from Africa, Spain, France, Italy, Turky in Europe, and Natolia, or the Leffer Afia, bounding it on the north; and the empire of Morocco, Algiers, Tunis, Tripoli, Barca, and Egypt, bounding it on the fouth. The Strait of Gibraltar being about 15 or 16 miles broad, a ftrong current fets through it out of the Atlantic Ocean into the Mediterranean conftantly, which requires a good gale of wind to ftem it.

MEDITULLIUM, is ufed by anatomifts for that fpungy fubftance between the two plates of the *cranium*, and in the interftices of all laminated bones. See DIPLOE.

MEDIUM, in logic, the mean or middle term of a fyllogifm, being an argument, reafon, or confideration, for which we affirm or deny any thing; or, it is the caufe why the greater extreme is affirmed or denied of the lefs in the conclufion.

MEDIUM, in arithmetic, or *arithmetical medium* or *mean*, called in the fchools *medium rei;* that which is equally diftant from each extreme, or which exceeds the leffer extreme as much as it is exceeded by the greater, in refpect of quantity, not of proportion; thus 9 is a medium betwixt 6 and 12.

Geometrical MEDIUM, called in the fchools *medium perfonæ*, is that where the fame ratio is preferved between the firft and fecond as between the fecond and third terms; or that which exceeds in the fame ratio or quota of itfelf, as it is exceeded: thus 6 is a geometrical medium between 4 and 9.

MEDIUM, in philofophy, that fpace or region through which a body in motion paffes to any point: thus æther is fuppofed to be the medium through which the heavenly bodies move; air, the medium wherein bodies move near our earth; water, the medium wherein fifhes live and move; and glafs is alfo a medium of light, as it affords it a free paffage. That denfity or confiftency in the parts of the medium, whereby the motion of bodies in it is retarded, is called the *refiftance of the medium;* which, together with the force of gravity, is the caufe of the ceffation of the motion of projectiles.

Subtile or *Ætherial* MEDIUM. See ETHER, ELECTRICITY, FIRE, &c.

MEDIUM, in optics, any fubftance through which light is tranfmitted.

MEDLAR, in botany. See MESPILUS.

MEDULLA, MEDULLA *Oblongata*, MEDULLA *Spinalis*. } See ANAT. n° 5. 396—399.

MEDUSA, one of the three Gorgons, daughter of Ceto and a fea-god named *Phorcus*. Neptune being in love with her, forced her in the temple of Minerva; upon which that goddefs changed her hair (which was extremely fair) into ferpents, the fight of which turned the beholders into ftones: but Perfeus, armed with Mercury's ax, with which he killed Argus, cut off Medufa's head, from whofe blood fprang Pegafus and Chryfaor. Minerva is reprefented bearing the picture of Medufa's head on her fhield, to terrify her enemies.

MEDUSA, in zoology, a genus of infects belonging to the order of mollufca. The body is gelatinous, roundifh, and depreffed; and the mouth is in the centre of the under part of the body. There are twelve fpecies, all natives of the fea. The moft remarkable is the fimplex, or armlefs, with a plain circumference; four apertures beneath; no tenacula. Thefe animals inhabit all our feas; are gregarious; often feen floating with the tide in vaft numbers; feed on infects, fmall fifh, &c. which they catch with their clafpers or arms. Many fpecies, on being handled, affect with a nettle-like burning, and excite a rednefs. The ancients, and fome of the moderns, add that they have an aphrodifiac property, and in feveral languages they are called by an obfcene name. They were known to the Greeks and Romans by the names of Πνευμα Θαλασσιος, and *pulmo marinus*, or fea-lungs. They attributed medicinal virtues to them. Diofcorides informs us, that, if rubbed frefh on the difeafed part, they cured the gout in the feet, and kibed heels. Ælian fays, that they were depilatory; and, if macerated in vinegar, would take away the beard. Their phofphoric quality is well known; nor was it overlooked by the ancients. Pliny obferves, that if rubbed with a ftick it will appear to burn, and the wood to fhine all over. The fame naturalift obferves, that when they fink to the bottom of the fea, they portend a continuance of bad weather.

MEGALE POLIS, (anc. geog.), dividedly (Ptolemy, Paufanias); or conjunctly *Megalopolis*, (Strabo): A town of Arcadia, built under the aufpices of Epaminondas, after the battle of Leuctra; many inconfiderable towns being joined together in one great city, the

the better to withftand the Spartans. It was the greateft city of Arcadia, according to Strabo.

MEGAMETER. See MICROMETER.

MEGARA (anc. geog.), a noble city, and the capital of the territory of Megaris, which for many years carried on war with the Corinthians and Athenians. It had for fome time a fchool of philofophers, called the *Megarici*, fucceffors of Euclid the Socratic, a native of Megara. Their dialect was the Doric; changed from the Attic, which it formely had been, becaufe of Peleponnefian colonifts who fettled there.

MEGARA (anc. geog.) formely called *Hybla*, a town towards the eaft coaft of Sicily; extinct in Strabo's time, though the name Hybla remained on account of the excellence of its honey. It was a colony of Megareans from Greece. *Rifus Megarius* denotes a hoarfe-laugh.

MEGARIS (anc. geog.), the country of the Megareans, which Pliny makes a part of Attica; and Strabo fays, fome were of this opinion; but he himfelf makes it a diftinct part; in which Scylax, Ptolemy, and the hiftories that relate the wars of the Athenians and Megareans, agree. It had Attica to the eaft, Bæotia to the north and weft, and the Ifthmus of Corinth to the fouth.

MEGARIS, a fmall ifland in the Tufcan fea, joined to Naples by a bridge. Now called *Caftello dell' ovo*.

MEGIDDO, (Judges v. 19.) A town of Galilee, recited (Jofhua xvii. 11.) among the cities of Manaffeh, in the tribe of Iffachar or Affer, on the weft fide of Jordan. Famous for the fate of Ahaziah and Jofiah, who perifhed there: near it was an open plain, fit for drawing up an army in battle-array. It was fituate to the north, contrary to its pofition in the common maps. The Canaanites being tributary to the Ifraelities, dwelt in it, Jofhua xvii. It was rebuilt by Solomon, 1 Kings ix.

MEIBOMIUS, the name of feveral learned Germans.—*John Henry Meibomius* was profeffor of phyfic at Helmftadt, where he was born, and at Lubec; he wrote the *Life of Mæcenas*, publifhed at Leyden in 4to. 1653, with feveral other learned works.—*Henry*, his fon, was born at Lubec in 1638; became profeffor of phyfic at Helmftadt; and, befides works in his own profeffion, publifhed *Scriptores rerum Germanicorum*, 3 vol. folio, 1688; a very ufeful collection, firft begun by his father.—*Marcus Meibomius*, of the fame family, publifhed a collection of feven Greek authors who had written upon ancient mufic, with a Latin verfion by himfelf; dedicated to queen Chriftina of Sweden, who invited him to her court. But fhe engaging him one day to fing an air of ancient mufic, while fomebody was ordered to dance to it, the immoderate mirth which this occafioned in the fpectators fo difgufted him, that he immediately left the court of Sweden. His edition of the Greek mythologifts, and notes upon Diogenes Laertius in Menage's edition, fhews him to have been a man of learning; but he fuffered no little raillery for his attempt to correct the Hebrew text of the Bible, by a kind of metre he fancies he had found out in thofe ancient writings.

MEISSEN, a confiderable town of Germany, in the electorate of Saxony, and in the margravate of Mifnia, with a caftle. It formerly belonged to the bifhop, but is now fecularized, and the inhabitants are Lutherans. In this place is a famous manufactory of porcelain, E. Long. 13. 33. N. Lat. 51. 15.

MELA (Pomponius), an ancient Latin writer, was born in the province of Bætica in Spain, and flourifhed in the reign of the emperor Claudius. His three books of Cofmography, or *De fitu orbis*, are written in a concife, perfpicuous, and elegant manner; and have been thought worthy of the attention and labours of the ableft critics. Ifaac Voffius gave an edition of them in 1658, 4to. with very large and copious notes. To this edition is added *Julii Honorii oratoris excerptum cofmographiæ*, firft publifhed from the manufcript, and *Æthici cofmographia*. Gronovius afterwards publifhed another edition with illuftrations by medals. In his laft edition are added five books *De geographia*, written by fome later author; by Jornandes, as Fabricius conjectures.

MELÆNA, or BLACK FLUX, in medicine. See MEDICINE, n°495.

MELAMPYRUM, COW-WHEAT; a genus of the angiofpermia order, belonging to the didynamia clafs of plants. There are four fpecies, all of them natives of Britain, and growing fpontaneoufly among cornfields. They are excellent food for cattle; and Linnæus tells us, that where they abound the yelloweft and beft butter is made. Their feeds, when mixed with bread, give it a dufky colour; and, according to fome authors, produce a vertigo, and other diforders of the head; but this is denied by Mr Withering, though he allows that they give it a bitter tafte.

MELANCHOLY, a kind of delirium attended with gloomy thoughts, heavinefs and forrow. See MEDICINE, n° 185, 428, 429.

MELANCTHON (Philip), born at Bretten in the Palatinate in 1495, was one of the wifeft and moft able men of his age among the Reformers, though of a mild temper, difpofed to accommodate rather than inflame difputes. In his youth he made an admirable progrefs in learning, and was made Greek profeffor at Wirtemberg in 1509. Here his lectures upon Homer, and the Greek text of St Paul's epiftle to Titus, drew to him a great number of auditors, and entirely effaced the contempt to which his low ftature and mean appearance had expofed him. Melanchthon reduced the fciences to fyftems; and acquired fuch reputation, that he had fometimes 2500 auditors. He foon entered into an intimate friendfhip with Luther, who taught divinity in the fame univerfity; and in 1519 they went together to Leipfic, to difpute with Eccius. The following years he was continually engaged in various employments; he compofed feveral books; he taught divinity; took feveral journeys, in order to found colleges and vifit churches; and in 1530 drew up a confeffion of faith, which goes by the name of the *Confeffion of Augfburg*, becaufe it was prefented to the emperor at the diet held in that city. All Europe was convinced, that he was not, like Luther, backward to accommodate the differences between the various fects of Chriftians. He hated religious difputes, and was drawn into them only through the neceffity of the part he was called to act in the world; and therefore would have facrificed many things, to have produced an union among the Proteftants. For this reafon, Francis I. the French king,

wrote to desire him to come and confer with the doctors of the Sorbonne, in order to agree with them about putting an end to all controversies; but though Luther endeavoured to persuade the elector of Saxony to consent to that journey, and though Melancthon himself desired it, that prince, whether he distrusted Melancthon's moderation, or was afraid of quarrelling with the emperor Charles V. would never grant his permission. The king of England also in vain desired to see him. Melancthon, in 1529, assisted at the conferences of Spires. In 1541, he was at the famous conferences at Ratisbon. In 1543, he went to meet the archbishop of Cologn to assist him in introducing the reformation into his diocese; but that project came to nothing: and in 1548, he assisted at seven conferences on the subject of the interim of Charles V. and wrote a censure on that interim, and all the writings presented at these conferences. He was extremely affected at the dissensions raised by Flaccus Illyricus. His last conference with those of the Roman communion was at Worms, in 1557. He died at Wittemburg in 1560, and was interred near Luther. Some days before he died, he wrote upon a piece of paper the reasons which made him look upon death as a happiness; and the chief of them was, that it "delivered him from theological persecutions." Nature had given Melancthon a peaceable temper, which was but ill suited to the time he was to live in. His moderation served only to be his cross. He was like a lamb in the midst of wolves. No body liked his mildness; it looked as if he was lukewarm; and even Luther himself was sometimes angry at it.

Melancthon was a man in whom many good as well as great qualities were wonderfully united. He had great parts, great learning, great sweetness of temper, moderation, contentedness, and the like, which would have made him very happy in any other times but those in which he lived. He never affected dignities, or honours, or riches, but was rather negligent of all these things; too much so in the opinion of some, considering he had a family; and his son-in-law Sabinus, who was of a more ambitious make, was actually at variance with him upon this very article. Learning was infinitely obliged to him on many accounts; on none more than this, that, as already observed, he reduced almost all the sciences which had been taught before in a vague irregular manner, into systems. Considering the distractions of his life, and the infinity of disputes and tumults in which he was engaged, it is astonishing how he could find leisure to write so many books. Their number is prodigious, insomuch that it was thought necessary to publish a chronological catalogue of them in the year 1582. His works indeed are not correct, and he himself owned it: but as he found them useful, he chose rather to print a great number, than to finish only a few; "which however," as Bayle says, "was postponing his own glory to the advantage of others." His constitution was very weak, and required great tenderness and management; which made Luther, as hot and zealous as he was, blame him for labouring too earnestly in the vineyard.

MELANTERIA, in natural history, a very beautiful fossil, of a dense, compact, and regular texture, and of an extremely bright pale yellow, resembling nothing so much as the purest gold. It is remarkably heavy; and is sometimes found in little irregular masses of the bigness of a pigeon's egg, which are broken with a slight blow: but it is usually met with in the form of a fine gold-coloured efflorescence on vitriolic and pyritical bodies; or in loose, shattery, and friable masses of a more dusky yellow; in which latter state it so much resembles a native sulphur, that it is frequently mistaken for one: however, it is not inflammable; but calcines in the fire to a greyish powder, which by burning longer changes to a deep and fine purple.

The Greeks used it externally, as a gentle escharotic and a styptic: they made it an ingredient in their ointments for old ulcers, and used to sprinkle the powder of it on fresh wounds in order to stop the hæmorrhage.

MELASTOMA, the AMERICAN GOOSEBERRY-TREE; a genus of the monogynia order, belonging to the decandria class of plants. There are a great many species, all of them natives of the warm parts of America, and very beautiful on account of the variegation of their leaves. Most of the leaves are of two different colours on their surfaces; the under side being either white gold-colour or russet, and their upper parts of different shades of green; so that they make a fine appearance in the hot-house all the year round. There are but few of these plants in the European gardens; which may perhaps have been occasioned by the difficulty of bringing over growing plants from the West Indies; and the seeds being small when taken out from the pulp of their fruits, rarely succeed. The best way is to have the entire fruits put up in dry sand as soon as they are ripe, and forwarded by the quickest contrivance to England. They should be immediately taken out when they arrive, and the seeds sown in pots of light earth, and plunged into a moderate hot-bed of tanner's bark. When the plants come up, and are fit to be removed, they must each be planted in a small pot, and plunged into the tan-bed; and afterwards treated as other exotic plants.

MELCHITES, in church-history, the name given to the Syriac, Egyptian, and other Christians of the Levant. The Melchites, excepting some few points of little or no importance, which relate only to ceremonies and ecclesiastical discipline, are in every respect professed Greeks: but they are governed by a particular patriarch, who resides at Damas, and assumes the title of *patriarch of Antioch*. They celebrate mass in the Arabian language. The religious among the Melchites follow the rule of St Basil, the common rule of all the Greek monks. They have four fine convents distant about a day's journey from Damas, and never go out of the cloister.

MELCHISEDECH, or MELCHISEDEK, (the order of); an order of priesthood, according to the scriptures of the Old and New Testament.

The first mention of Melchisedech is in Genesis xiv. 16, 17, 18. where it is related, that, when Abraham had rescued his brother Lot and all his goods out of the hands of the five kings, he was met, upon his return, by Melchisedech, king of Salem, who "brought forth bread and wine; and he was the priest of the Most High God." It is added, that he blessed A-

bra-

braham; who acknowledged his priesthood, by giving him tythes of all he had taken from the enemy.

The next mention of Melchisedech is by the Royal Psalmist, who, speaking prophetically of the Messiah, says, "Thou art a priest for ever after the order of Melchisedech."

Lastly, St Paul applies the story of Melchisedech to our Saviour, citing the very words of the Psalmist. And, in another place, he gives this account of Melchisedech: "This Melchisedech, king of Salem, priest of the Most High God, who met Abraham returning from the slaughter of the kings, and blessed him; to whom Abraham gave a tenth part of all; first being by interpretation king of righteousness, and after that also king of Salem, which is, king of peace; without father, without mother, without descent; having neither beginning of days, nor end of life; but made like unto the Son of God, abideth a priest continually."

From these passages it appears, that Melchisedech, whoever he was, was a type of Jesus Christ, and his priesthood an image of our Saviour's.

Innumerable difficulties have been started upon the subject of Melchisedech. The first relates to his country, or the place where he reigned. Most authors take Salem to be the same as Jerusalem: but St Jerom places it near Scythopolis, where they still pretended to shew the ruins of Melchisedech's palace. He thinks it was at this place that Jacob arrived, after his passage over Jordan, when he returned from Mesopotamia.

The next difficulty relates to his person. It is generally agreed by learned men, that, when the apostle says he was *without father* and *without mother*, no more is meant than that he is introduced into the history of Abraham without acquainting us who he was or whence he came, when he lived or when he died. Nevertheless, some have taken St Paul's words literally, and contended, that he was not of human, but divine nature. Origen and Didymus took him to be an angel; and the author of the *Questions on the Old and New Testament* pretended he was the Holy Ghost, who appeared to Abraham in a human form.

About the beginning of the third century, arose the heresy of the Melchisedechians, who affirmed, that Melchisedech was not a man, but a heavenly power, superior to Jesus Christ: For Melchisedech, they said, was the intercessor and mediator of the angels; but Jesus Christ was so only for men, and his priesthood only a copy of that of Melchisedech. This heresy was revived in Egypt by one Hierax, who pretended that Melchisedech was the Holy Ghost.

The Arabic catena upon the ninth chapter of Genesis makes Melchisedech to be descended from Shem by his father, and from Japhet by his mother. Heraclas, or Heraclim, his father, was, they say, son or grandson of Phaleg, and son of Heber; and his mother, named *Salathiel*, was daughter of Gomer, son of Japheth. Cedrenus, and others, derive Melchisedech from an Egyptian stock. They say his father was called *Sidon* or *Sida*, and was the founder of the city of Sidon the capital of Phœnicia. Suidas says, he was of the cursed race of Canaan; for which reason the scripture does not mention his genealogy.

The Jews and Samaritans believed Melchisedech to be the same with the patriarch Shem; which opinion has been followed by a great number of modern writers. M. Jurieu has undertaken to prove, that he is the same as Cham or Ham. It would be endless to recount all the opinions upon this matter; we shall therefore only add, that Peter Cunæus, and Peter du Moulin, have asserted, that Melchisedech, who appeared to Abraham, was the Son of God; and that the patriarch worshipped him, and acknowledged him for the Messiah.

MELCOMB-REGIS, a town of Dorsetshire, in England, situated in W. Long. 2. 32. N. Lat. 50. 40. The streets are broad and paved; and there is an excellent harbour, by which they carry on a pretty good foreign trade.

MELEAGER, in fabulous history, the son of Æneas king of Caledonia, and Althæa the daughter of Thestius, was no sooner born than the Parcæ put a firebrand in the fire, saying, "This child shall live as long as this firebrand shall last." The three Parcæ being gone, Althæa took the brand out of the fire, and preserved it with great care. Meleager at length discovered great courage in killing the famous Caledonian boar which laid waste the country, and presented the head to Atalanta who had given the monster the first blow: but Plexippus and Toxeus, the brothers of Althæa, resolving to have the head, Meleager killed them in the quarrel, and married Atalanta, by whom he had Parthenope; but Althæa, in revenge for the death of her two brothers, threw the fatal brand on the fire, which occasioned Meleager's death.

MELEAGER, a Greek poet, the son of Eucrates, was born at Seleucia in Syria, and flourished under the reign of Seleucus VI. the last king of Syria. He was educated at Tyre; and died in the island of Coos, anciently called *Merope*. He there composed the Greek epigrams called by us the *Anthologia*. The disposition of the epigrams in this collection was often changed afterwards, and many additions have been made to them. The monk Planudes put them into the order they are in at present in the year 1380.

MELEAGRIS, in ornithology, the TURKY, a genus of birds belonging to the order of gallinæ. The head is covered with spongy caruncles; and there is likewise a membranaceous longitudinal caruncle on the throat. There are three species, *viz.* 1. The gallopavo, or North American turky of Ray, has a caruncle both on the head and throat; and the breast of the male is bearded. He lives upon grain and insects: when the cock struts, he blows up his breast, spreads and erects his feathers, relaxes the caruncle on the forehead, and the naked parts of the face and neck become intensely red.—Barbot informs us, that very few turkies are to be met with in Guinea, and those only in the hands of the chiefs of the European forts; the Negroes declining to breed any on account of their tenderness, which sufficiently proves them not to be natives of that climate. He also remarks, that neither the common poultry nor ducks are natural to Guinea, any more than the turkey. Neither is that bird a native of Asia: the first that were seen in Persia were brought from Venice by some Armenian merchants. They are bred in Ceylon, but not found wild. In fact, the turky, properly so called, was unknown to the ancient naturalists, and even to the old world, before

before the discovery of America. It was a bird peculiar to the new continent, and is now the commonest wild-fowl in the northern parts of that country. It was first seen in France, in the reign of Francis I.; and in England, in that of Henry VIII. By the date of the reign of these monarchs, the first turkies must have been brought from Mexico, the conquest of which was completed A. D. 1521. Ælian mentions a bird found in India, which some writers have suspected to be the turky; but Mr Pennant concludes, with Gesner, that it was either the peacock, or some bird of that genus. On consulting some gentlemen who had resided long in the Indies, Mr Pennant is of opinion, that though the turky is bred there, it is only considered as a domestic bird, and not a native of the country.

2. The cristata, or Brasilican pheasant of Ray, has an erect crest of feathers on the head, and violet-coloured temples; it has a caruncle on the throat, but none on the head.

Plate CLXXVI. 3. The satyra, or horned pheasant of Edwards, has two blue horns behind its eyes, and a red body spotted with black and white. It is a native of Bengal.

MELES, in zoology. See Ursus.

Meles, (anc. geog.), a fine river running by the walls of Smyrna in Ionia, with a cave at its head, where Homer is said to have written his poems. And from it Homer takes his original name *Melasigenes*, given him by his mother Crithies, as being born on its banks. (Herodotus).

MELIA, Azaderach, or the *Bead-tree;* a genus of the monogynia order, belonging to the decandria class of plants. There are three species, all of them exotic trees of the Indies, rising near 20 feet high; adorned with large pinnated or winged leaves, and clusters of pentapetalous flowers. They are all propagated by seeds sown on hot-beds.

MELIANTHUS, Honey-flower; a genus of the angiospermia order, belonging to the didynamia class of plants. There are two species. 1. The major hath a thick, ligneous, spreading root; many upright, ligneous, durable stalks, rising six or eight feet high; garnished with large pinnated leaves, of four or five pair of serrated lobes terminated by an odd one; and, from the sides and tops of the stalks, long spikes of chocolate-coloured flowers. 2. The minor, hath a root like the former; upright, ligneous, soft, durable stalks, rising four or five feet high; garnished with smaller pinnated leaves; and from the sides and ends of the branches, long, loose, pendulous bunches of flowers tinged with green, saffron colour, and red. Both the species flower about June; but rarely produce seeds in this country. They are very ornamental, both in foliage and flower, and merit admittance in every collection. They are easily propagated by suckers and cuttings. They thrive best in a dry soil, and in a sheltered warm exposure.

MELIBOEA, (anc. geog.), an island of Syria, at the mouth of the Orontes; which, before it falls into the sea, forms a spreading lake round it. This island was famous for its purple dye. Thought to be a colony of Thessalians; and hence Lucretius's epithet *Thessalicus*.

MELICA, Ropegrass; a genus of the digynia order, belonging to the triandria class of plants. There are three species; of which the most remarkable is the nutans. It is a native of several parts of Britain and the adjacent islands; and the inhabitants of some of the western islands make ropes of it for fishing-nets, as it will bear the water for long time without rotting.

MELICERES, in surgery, a kind of encysted tumours, so called when their contents are of the consistence of honey.

MELILLA, an ancient town of Africa in the kingdom of Fez, and in the province of Garet. It was taken by the Spaniards in 1469, but returned back to the Moors. W. Long. 2. 9. N. Lat. 35. 20.

MELILOT. See Trifolium.

MELINDA, a kingdom on the east coast of Africa, situated, according to some, between the third and fourth degree of South Latitude; though there is great disagreement among geographers as to its extent. It is allowed by all, however, that the coasts are very dangerous; being full of rocks and shelves, and the sea at some seasons very liable to tempests. The kingdom of Melinda is for the most part rich and fertile; producing almost all the necessaries of life except wheat and rice, both which are brought thither from Cambaya and other parts; and those who cannot purchase them make use of potatoes in their stead, which are here fine, large, and in great plenty. They likewise abound with great variety of fruit-trees, roots, plants, and other esculents, and with melons of exquisite taste. They have also great plenty of venison, game, oxen, sheep, hens, geese, and other poultry, &c. and one breed of sheep whose tails weigh between 30 and 40 pounds. The capital city is also called *Melinda*.

MELINUM, in natural history, the name of an earth, famous in the earliest ages of painting, being the only white of the great painters of antiquity; and, according to Pliny's account, one of the three colours with which alone they performed all their works. It is a fine, white, marly earth, of a very compact texture, yet remarkably light; a sort of texture which must render any earth fit for the painter's use, that is of a proper colour. It is frequently found forming a stratum in the earth, lying immediately under the vegetable mould. It is of a very smooth but not glossy surface; is very soft to the touch; adheres firmly to the tongue; is easily broken between the fingers; and stains the skin in handling. It melts readily in the mouth, and is perfectly fine; leaving not the least grittiness between the teeth: thrown into water, it makes a loud bubbling and hissing noise, and moulders away into a fine powder. It does not ferment with acids; and suffers no change in the fire. These are the characters by which the melinum of the ancients is distinguished from all other white earths. It is still found in the same place from which the painters of old had it, *viz.* the isle of Milo or Melos, from whence it had its name; and is common in most of the adjacent islands. It has of late been tried here as a paint; but is found not to make such a bright paint as the other substances now employed. It is not, however, liable, like them, to turn yellow: hence it would seem to be worth the consideration of persons in the colour-trade; especially as it might be had, in any quantities, for the carriage.

MELISSA, Baum; a genus of the gymnospermia order, belonging to the didynamia class of plants. There

There are feveral fpecies; but the moft remarkable are the following. 1. The officinalis, or common baum, hath fibrous perennial roots; many upright, fquare, branchy, annual ftalks, rifing two or three feet high: garnifhed with oblong, indented, oppofite leaves by pairs, two or three inches long, and half as broad; and, from the upper axillas, verticillate clufters of fmall white flowers, upon fingle footftalks. There is alfo a kind with variegated leaves. 2. The grandiflora, or Hetrurian calamint, hath fibrous perennial roots, and annual ftalks, rifing about a foot high; garnifhed with oblong, oval, indented, hairy oppofite leaves; and from the upper axillas verticillate clufters of large purple flowers, on forked footftalks. 3. The calamintha, or common calamint of the fhops, hath fibrous perennial roots; upright, fquare, branchy hairy ftalks, rifing a foot high; roundifh, indented, oppofite leaves; and verticillate clufters of fmall bluifh flowers, on forked footftalks as long as the flowers. All thefe fpecies are eafily propagated by offsets.

Medicinal Ufes. The firft fpecies, when in perfection, has a pleafant fmell, fomewhat of the lemon kind; and a weak, roughifh, aromatic tafte. The young fhoots have the ftrongeft flavour; the flowers, and the herb itfelf when old, or produced in very rich moift foils, or rainy feafons, is much weaker both in fmell and tafte. Baum is appropriated, by the writers on the materia medica, to the head, ftomach, and uterus; and in all diforders of thefe parts, is faid to do extraordinary fervice. So high an opinion have fome chemifts entertained of this plant, that they have expected to find in it a medicine which fhould prolong life beyond the ufual period. The prefent practice, however, holds it in no great efteem; and ranks it (where it certainly deferves to be) among the weaker corroborants. Infufions of the leaves in water fmell agreeably of the herb, but have not much tafte, though on being infpiffated they leave a confiderable quantity of a bitterifh auftere extract. Infufions of baum do not, like other aromatics, offend the head, as is complained off from fage, &c. Cold infufions in water, or fpirit, are far better than the cohobated diftilled water, and are the beft preparations from the plant. On diftilling the frefh herb with water, it impregnates the firft running pretty ftrongly with its grateful flavour. When large quantities are fubjected to the operation at once, there feparates and rifes to the furface of the aqueous fluid a fmall portion of effential oil, which fome call *ol. Syriæ*, and others *ol. Germanis*. It is of a yellowifh colour, and a very fragrant fmell.

MELISSUS of Samos, a Greek philofopher, was the fon of Rhagines and the difciple of Parmenides; and lived about 520 B. C. The Ephefians gave him the poft of admiral, and invefted him with extraordinary power. He pretended that the univerfe is infinite, immoveable, alone, and without a vacuum.

MELITE, (anc. geog.), an ifland referred to Africa by Scylax and Ptolemy; but nearer Sicily, and allotted to it by the Romans: commended for its commodious harbours; for a city well built, with artificers of every kind, efpecially weavers of fine linen; all owing to the Phœnicians, the firft colonifts. Now *Malta*; remarkable for St Paul's fhipwreck.

Melite, *Melita*, or *Melitina Infula*; an ifland on the coaft of Illyricum in the Adriatic. The *Catuli Melitæi*, (Pliny), were famous. Now *Melede*, the name of the ifland Samos.

Melite, (anc. geog.), a town of Ionia, ftruck out of the number of Ionian towns on account of the arrogance of the people, and Smyrna admitted in lieu of it. The fituation not faid.

MELITENSIS terra, the *Earth of Malta*: an earth, of which there are two very different kinds; the one of the genus of boles, the other of the marles. The latter is that known by medicinal authors under this name, the former is the Malta earth now in ufe; but both being brought from the fame place, are confufedly called by the fame name. The Maltefe marle, which is the *terra Melitenfis* of medicinal authors, is a loofe, crumbly, and very light earth, of an unequal and irregular texture; and, when expofed to the weather, foon falls into fine foft powder: but, when preferved and dried, it becomes a loofe, light mafs, of a dirty white colour, with a greyifh caft: it is rough to the touch, adheres firmly to the tongue, is very eafily crumbled to powder between the fingers, and ftains the hands. Thrown into the water, it fwells, and afterwards moulders away into a fine powder. It ferments very violently with acid menftruums. Both kinds are found in great abundance in the ifland of Malta, and the latter has been much efteemed as a remedy againft the bites of venomous animals. The other has fupplied its place in the German fhops; and is ufed there as a cordial, fudorific, and aftringent.

MELITO (canonized), bifhop of Sardis in Lydia, in the fecond century; is remarkable for the apology he prefented to the emperor Aurelius, in favour of the Chriftians; on which Eufebius and the other ancient ecclefiaftical writers beftow great praifes: but that apology and all Melito's other works, are loft.

MELITUS, Greek orator and poet, the accufer of Socrates. The Athenians, after the death of Socrates, difcovering the iniquity of the fentence they had paffed againft that great philofopher, put Melitus to death 400 B. C.

MELLER, a lake of Sweden, 80 miles long, and 30 broad; on which ftands the city of Stockholm.

MELLI, with the country of the Mundingoes, in Africa. The country formerly called *Melli*, now chiefly inhabited by the Mundingoes, who ftill retain pretty much of the character afcribed to the people of Melli, lies to the fouth of the river Gambia; on the weft it borders on the kingdom of Kabo; on the fouth it has *Melli*, properly fo called, and the mountains that part it from Guinea; and on the eaft it extends to the kingdom of Gago. A great part of this country we are little acquainted with; as is the cafe with regard to moft of the inland territories of Africa, but towards the fea-coaft this country is a little better known.

The firft place of note we meet with is Kachao, a Portuguefe colony, fituated on the river of St Domingo, which falls into the fea about 26 leagues below this town.—About 26 leagues above Kachao, on the fame fide of the river, is another trading town called *Farini*, where, in the months of October and November, one may trade for about half the quantity of wax and ivory which is traded for at Kachao. Here are alfo fome flaves to be bought.—Bot is a village near the mouth of the river Gefves, where moft of the traders buy rice; which is in great plenty there, and very good

good.—Gesves is a village on a river of the same name, on which the Portuguese have a factory. At Gesves one may trade yearly for 250 slaves, 80 or 100 quintals of wax, and as many of ivory. Near the mouth of the river of Gesves is a village called *Kurbali*, where there is a considerable trade for salt: here are also some slaves and ivory. Rio Grande, or the Great River, runs about 10 or 12 leagues to the south of the river of Gesves. About 80 leagues from the mouth of it is a nation of Negroes, who are good traders in ivory, rice, millet, and some slaves. They are called *Analons*. Over-against the mouth of Rio Grande, is a cluster of islands called *Bissago Isles*; the most considerable of which is Cassagut, being about six leagues long and two broad; its soil is very good, and produces millet, rice, and all kinds of pulse, besides orange and palm-trees, and many others. This island, with those of Carache, Canabac, and La Gallina, are the only ones where the Europeans may trade with some security. They trade, however, sometimes at the other islands, but they must be extremely cautious; and yet, after all their precautions, they will be robbed and murdered if they venture to go ashore. The river Nunho runs 16 leagues to the south of Rio Grande; it is very considerable, and comes from a vast distance in land. One may buy here 300 quintals of ivory and 100 slaves a-year. Rice grows here admirably well, and is very cheap. There are every-where sugar-canes which grow naturally; and plants of indigo, which might turn to good account. The trade is carried on here from March till August. In the river of Sierra Leone, the late Royal African company of England had, in the year 1728, two islands; the one, called *Tasso*, a large flat island, near three leagues in circumference, in which the company's slaves had a good plantation: the rest of the island is covered with wood, among which are silk cotton-trees of an unaccountable size. The other island is *Bense*, whereon stood a regular fort. It was formerly the residence of one of the English chiefs.

MELOCHIA, Jews mallow; a genus of the pentandria order, belonging to the monodelphia class of plants. There are several species; but the only remarkable one is the olitorius, or common Jews-mallow, which is a native of the warm parts of Asia and America. It is an annual plant, which rises about two feet high, dividing into several branches, garnished with leaves of different sizes and forms: some are spear-shaped, others are oval, and some almost heart-shaped: they are of a deep green, and slightly indented on their edges, having near their base two bristly reflexed segments. They have very long slender footstalks, especially those which grow on the lower part of the branches. The flowers sit close on the opposite side of the branches to the leaves, coming out singly; they are composed of five small yellow petals, and a great number of stamina surrounding the oblong germen, which is situated in the centre of the flower and afterwards turns to a rough swelling capsule two inches long, ending in a point, and having four cells filled with angular greenish seeds. This species is cultivated about the city of Aleppo in Syria, and in the East Indies, as a pot-herb; the Jews boiling the leaves, and eating them with their meat. It is supposed by Rauwolf to be the *olus Judaicum* of Avicenna, and the *corchorum* of Pliny.

MELODUNUM, (anc. geog.), Cæsar; a town of the Senones in Gallia Celtica above Lutetia; now *Melun*, in the isle of France on the Seine.

MELODY, in music, a succession of sounds ranged in such a manner, according to the laws of rhythmus and modulation, that it may form a sentiment agreeable to the ear. Vocal melody is called *singing*; and that which is performed upon instruments may be termed *symphonic melody*.

The idea of rhythmus necessarily enters into that of melody. An air is not an air but in proportion as the laws of measure and quantity are observed. The same succession of sounds is susceptible of as many different characters, as many different kinds of melody, as the various ways by which its emphatic notes, and the quantities of those which intervene, may be diversified; and the change in duration of the notes alone, may disguise that very succession in such a manner that it cannot be known. Thus, melody in itself is nothing; it is the rhythmus or measure which determines it, and there can be no air without time. If then we abstract measure from both, we cannot compare melody with harmony; for to the former it is essential, but not at all to the latter.

Melody, according to the manner in which it is considered, has a relation to two different principles. When regarded only as agreeable to the proportions of sound and the rules of modulation, it has its principle in harmony; since it is a harmonical analysis, which exhibites the different gradations of the scale, the chords peculiar to each mode, and the laws of modulation, which are the sole elements that compose an air. According to this principle, the whole power of melody is limited to that of pleasing the ear by agreeable sounds, as the eye may be pleased with an agreeable assemblage of suitable colours. But when considered as an imitative art, by which we may affect the mind with various images, excite different emotions in the heart, inflame or soothe the passions; by which, in a word, we produce different effects upon our moral faculties, which are not to be effectuated by the influence of external sense alone, we must explore another principle for melody: for in our whole internal frame there appears to be no power upon which either harmony alone, or its necessary results, can seize, to affect us in such a manner.

What then is the second principle? It is as much founded on nature as the first; but, in order to discover its foundation in nature, it will require a more accurate though simpler observation, and a more exquisite degree of sensibility in the observer. This principle is the same which varies the tone of the voice, when we speak, according as we are interested in what we say, and according to the different emotions which we feel in expressing it. It is the accent of languages which determines the melody of every nation; it is the accent which determines us to employ the emphasis of speaking while we sing, and to speak with more or less energy according as the language which we use is more or less accented. That language whose accents are the most sensible, ought to produce a more passionate and more lively melody; that which has little accentuation, or none at all, can only produce a cold and languid melody, without character

Melody. racter and without expreffion. Thefe are the true principles: in proportion as we depart from them, when we fpeak of the power of mufic upon the humanheart, we fhall become unintelligible to ourfelves and others; our words will be without meaning.

If mufic does not imprefs the foul with images but by melody, if from thence it obtains its whole power, it muft follow, that all mufical founds which are not pleafing by themfelves alone, however agreeable to harmony they may be, is not an imitative mufic; and, being incapable, even with its moft beautiful chords, either to prefent the images of things, or to excite the finer feelings, very foon cloys the ear, and leaves always the heart in cold indifference. It follows likewife, that notwithftanding the parts which harmony has introduced, and which the prefent tafte of mufic fo wantonly abufes, wherever two different melodies are heard at the fame time, they counteract each other, and deftroy the effects of both, however beautiful each may be when performed alone: from whence it may be judged with what degree of tafte the French compofers have introduced in their operas the miferable practice of accompanying one air with another, as well in finging, which is the native expreffion of pathos and fentiment, as in inftrumental performances; which is the fame thing as if whimfical orators fhould take it in their heads to recite two orations at the fame time, that the elegance of each might derive more force from the other.

So much for Rouffeau. The tranflator, however, has reafon to fear, that the caufes by which national melody is diverfified and characterifed, are more profound and permanent than the mere accentuation of language. This indeed may have great influence in determining the nature of the rhythmus, and the place of emphatic notes; but very little in regulating the nature of the emphafis and expreffion themfelves. If Rouffeau's principle be true in its full extent, he muft of neceffity acknowledge, that an air which was never fet or intended for words, however melodious, cannot be imitative: he muft likewife confefs, that what is imitative in one nation cannot be fuch in another: nor can it be denied upon his hypothefis, that the recitative, which is formed upon the mode of fpeaking, is the moft forcible of all melodies; which is abfurd. His other obfervations are at once judicious and profound. Though it is impoffible to exhibit the beauty and variety of harmony by playing the fame melody at the fame time upon different keys, admitting thofe keys to form among themfelves a perfect chord, which will of confequence preferve all the fubfequent notes in the fame intervals; yet this perfect harmony would by no means be uniformly pleafing to the ear. We muft therefore of neceffity introduce lefs perfect chords to vary and increafe the pleafure, and thefe chords in any complex fyftem of mufic muft of neceffity produce diffonances. It then becomes the bufinefs of the compofer to be careful that thefe difcords may arife as naturally from, and return as naturally to, perfect harmony as poffible. All thefe caufes muft inevitably vary the melody of the different parts; but ftill amidft all thefe difficulties, the artift ought to be zealous in preferving the melody of each as homogeneous with the others as poffible, that the refult of the whole may be in fome meafure uniform. Otherwife, by counteracting each other, the parts will reciprocally deftroy the effects one of another.

Meloe. MELOE, in zoology, a genus of infects of the order of coleoptera. The antennæ are jointed, the laft joint being oval; the breaft is roundifh; the elytra are foft and flexible; and the head is inflected and gibbous. There are 16 fpecies, principally diftinguifhed by their colour. The moft remarkable is the veficatorius, or cantharis of the fhops; which, when bruifed, is univerfally ufed as a bliftering plafter. Thefe infects are of a fhinning green colour, intermingled with more or lefs of a blue and a gold yellow. They are found adhering to different kinds of trees and herbs, in Spain, Italy, and France: the largeft and moft efteemed come from Italy.

Cantharides are extremely acrimonious: applied to the fkin, they firft inflame, and afterwards excoriate the part, raifing a more perfect blifter than any of the vegetable acrids, and occafioning a more plentiful difcharge of ferum. All the bliftering compofitions have cantharides for their bafis. The external application of cantharides is often followed by a ftrangury, accompanied with thirft and feverifh heat: this inconvenience may be remedied by foft unctuous or mucilaginous liquors liberally drank.

Cantharides taken internally often occafion a difcharge of blood by urine, with exquifite pain: if the dofe is confiderable, they feem to inflame and exulcerate the whole inteftinal canal; the ftools become mucous and purulent; the breath fetid and cadaverous; intenfe pains are felt in the lower belly; the patient faints, grows giddy, raving mad, and dies. All thefe terrible confequences have fometimes happened from a few grains. Herman relates, that he has known a quarter of a grain inflame the kidneys, and occafion bloody urine with violent pain. There are neverthelefs cafes in which this ftimulating fly, given in larger dofes, proves not only fafe, but of fingular efficacy for the cure of difeafes that yield little to medicines of a milder clafs. In cold phlegmatic fluggifh habits, where the vifcera are overloaded, and the kidneys and ureters obftructed with thick vifcid mucous matter, cantharides have excellent effects: here the abounding mucus defends the folids from the acrimony of the fly, till it is itfelf expelled; when the medicine ought to be difcontinued. Groenvelt employed cantharides with great fuccefs in dropfies, obftinate fuppreffions of urine, and ulcerations of the bladder; giving very confiderable dofes made into bolufes with camphor; and interpofing large draughts of emulfions, milk, or other emollient liquids: by this means, the exceffive irritation, which they would otherwife have occafioned, was in great meafure prevented. The camphor did not perhaps contribute fo much to this effect as is generally imagined: fince it has no fenfible quality that promifes any confiderable abatement of the acrimony of cantharides: nitre would anfwer all that the camphor is fuppofed to perform; this, with milk, or emollient mucilaginous liquors, drank in large quantity, are the beft correctors. Cantharides, in very fmall dofes, may be given with fafety alfo in other cafes. Dr Mead obferves, that the obftinate gleetings which frequently remain after the cure of venereal maladies, and which rarely yield to balfamic medicines,

cines, are effectually remedied by cantharides; and that no one remedy is more efficacious in leprous disorders; in which laft, proper purgatives are to be occafionally taken during the ufe of the cantharides. The beft and fafeft preparation of cantharides for thefe purpofes, is a fpirituous tincture; and indeed in all cafes, the tincture is far preferable, for internal ufe, to the fly in fubftance.

The virtues of cantharides are extracted by rectified fpirit of wine, proof fpirit, and water; but do not arife in diftillation. The watery and fpirituous extracts blifter as freely as the fly in fubftance; whilft the fly remaining after the feveral menftrua have performed their office, is to the tafte infipid, and does not in the leaft blifter or inflame the fkin.

MELON, in botany. See CUCUMIS.

MELOTHRIA, in botany; a genus of the monogynia order, belonging to the triandria clafs of plants. There is only one fpecies, viz. the pendula, a native of Carolina, Virginia, and alfo many of the American iflands. The plants ftrike out roots at every joint, which faften themfelves into the ground, by which means their ftalks extend to a great diftance each way. The flowers are very fmall, in fhape like thofe of the melon, of a pale fulphur colour. The fruit in the Weft Indies grows to the fize of a pea, is of an oval figure, and changes to black when ripe: thefe are by the inhabitants fometimes pickled when they are green. In Britain the fruit are much fmaller, and are fo hidden by the leaves that it is difficult to find them. The plants are too tender to be reared in this country without artificial heat.

MELPOMENE, in fabulous hiftory, one of the nine mufes, and the inventrefs of tragedy. She is commonly reprefented with a ferious countenance, and in a theatrical drefs, holding crowns and fceptres in one hand, and a dagger in the other.

MELREY, or MELROSE, a town of Scotland, in the county of Merfe, and on the confines of Tweedale, feated on the fouth-fide of the river Tweed; with an ancient abbey now in ruins. W. Long. 2. 32. N. Lat. 55. 32.

This abbey was founded by king David I. in 1136. He peopled it with Ciftertians, brought from Rivale abbey in Yorfhire, and dedicated it to the virgin Mary. At the reformation James Douglas was appointed commendator, who took down much of the building, in order to furnifh materials for a large houfe to himfelf, which ftill remains, and is dated 1590. Nothing is left of the abbey, excepting a part of the cloifter walls, elegantly carved; but the ruins of the church are of moft uncommon beauty. Part is at prefent ufed for divine fervice, the reft uncovered; but every part does great honour to the architect.—Alexander II. was buried beneath the great altar, and it is alfo the place of interment of the Douglafes and other potent families.—Its fituation is extremely pleafant.

MELT OF FISHES. In the melt of a living cod there are fuch numbers of thofe animalcules faid to be found in the femen of all-male animals, that in a drop of its juice, no larger than a grain of fand, there are contained more than 10,000 of them; and, confidering how many fuch quantities there are in the whole melt of one fuch fifh, it is not incredible, that there are more animals in one melt of it, than there are living men at one time upon the face of the earth. However ftrange and romantic fuch a conjecture muft appear, a ferious confideration and calculation will make it appear very plain. An hundred fuch grains of fand as thofe juft mentioned will make about an inch in length; therefore in a cubic inch there will be a million of fuch fands; and if there be 10,00 animals in each of thofe quantities, there muft be in the whole 150,000 millions; which is a number vaftly exceeding that of mankind, even fuppofing the whole earth as populous as Holland.

MELTING CONE, in effaying, an hollow cone of brafs or caft iron, into which melted metalline fubftances are thrown, in order to free them from their fcoriæ. When a fmall quantity of matter is melted, it will be fufficient to rub the infide of the cone with greafe; but when the quantity is very large, efpecially if it contains any thing fulphureous, this caution of tallowing the moulds is not fufficient. In this cafe the effayer has recourfe to a lute reduced to thin pap with water, which effectually prevents any injury to the cone.

MELVIL (Sir James), defcended from an honourable Scots family, being the third fon of the laird of Kaeth, was born about the middle of the 16th century. He went to France, very young, in the capacity of page to qneen Mary, then married to the dauphin; and on the death of her hufband, followed her to Scoland, where he was made gentleman of her chamber, and admitted a privy-counfellor. She employed him in her moft important concerns, till her unhappy confinement in Lochleven, all which he difcharged with the utmoft fidelity; and, from his own accounts, there is reafon to conclude, that, had fhe taken his advice, fhe might have avoided many of her misfortunes. When fhe was prifoner in England, fhe recommended him ftrongly to her fon James; with whom he continued in favour and employment until the death of queen Elizabeth: James would then have taken him to England; but Melvil, now grown old, was defirous of retiring from bufinefs, and in his retirement he drew up the memorirs of his paft life for the ufe of his fon. Thefe memoirs were accidentally found in Edinburgh caftle, in the year 1660, though nobody knew how they came to be depofited there; and were publifhed in folio in 1683.

MEMBER, in architecture, denotes any part of a building; as a frize, cornice, or the like. This word is alfo fometimes ufed for the moulding.

MEMBER *of Parliament*. See PARLIAMENT.

MEMBRANE, in anatomy, a pliable texture of fibres interwoven together in the fame plane.

MEMNON, in fabulous hiftory, was the fon of Tithonus and Aurora. Having led his troops to the affiftance of Priam, in order to raife the fiege of Troy, he was killed by Achilles; when his body being placed on a funeral pile, was, at Aurora's defire, transformed into a bird.

MEMNON *of Rhodes*, one of the generals of Darius king of Perfia, advifed that prince to lay wafte the country, in order to deprive Alexander the Great's army of fupport, and afterwards to attack Macedon; but

but this counsel was disapproved by Darius's other generals. Memnon behaved at the passage of the Granicus like an experienced general. He afterwards defended the city of Miletum with great courage; seized the islands of Chio and Lesbos; spread terror throughout all Greece; and would have put a stop to the conquests of Alexander, if he had not been prevented by death. Barsina, Memnon's widow, was taken prisoner with Darius's wife, and Alexander had a son by her named *Hercules*.

MEMOIRS, in matters of literature, a species of history, written by persons who had some share in the transactions they relate; answering to what the Romans called *Commentarii*.—The journals of the proceedings of a literary society, or a collection of matters transacted therein, are likewise called *Memoirs*.

MEMORY, a faculty of the human mind, whereby it retains and recalls the ideas it has once perceived. See METAPHYSICS, n° 42.

Memory depends very much upon the temper and constitution of the body. In some, it is not so susceptive of impressions; in others, it is not sufficiently retentive: and as the seat of the memory is in the brain, whatever is hurtful to this latter, must prejudice the former. Too much sleep clouds the brain, and too little over-heats it; therefore either of these extremes must of course hurt the memory. All intemperance likewise, and excess of passion, have the same ill effect.

When we would commit any thing to memory, our first concern should be to understand it thoroughly. For we can never retain those things long, of which we have but an imperfect knowledge. Likewise order and method in the discourse itself is a great help to the memory. Where things have a mutual dependance upon each other, and go on in a series, the thoughts pass more readily from one to another, than where they lie confused and without any connection. The mind should also be free at such times, and have nothing else to take off its attention. Nothing is a greater hindrance to the memory than a crowd of ideas, and those of different kinds, flowing in upon the mind at the same time. They justle out one another, so that but few of them settle; and if they do, it is in such a confused and disorderly manner, that when they come to be surveyed by reflection, little can be made of them.

To write down any thing is likewise a great advantage towards remembering it. For the very action of writing helps very much to imprint it upon the mind, by engaging it to a closer attention, and causing it to dwell longer upon every part than otherwise it would do only in reading. And therefore the Jewish doctors tell us, it was for this reason that the kings of Israel were enjoined always to write out a copy of the law with their own hand. And the fairer a thing is written, it is with greater ease committed to memory. This may possibly at first seem to have little in it; but if we consult experience, we shall generally find, that those things make the deepest impression upon the mind, which affect the senses in the most lively and agreeable manner. As we receive most of our ideas through them, the stronger impulse is made upon the organ, the greater attention it excites in the mind; and what we most attend to, we retain longest.

A little experience and observation will help a person to discover the strength of his memory. And care should be taken not to over-burden it. A long discourse therefore should be committed to memory by parts, so much at once as the memory can well receive and retain. These parts should not be too many, for fear of confusion. And as it is most likely we may be at a loss in passing from one part to another, it will not be amiss in a more particular manner to impress upon the the mind the beginnings of them. One letter often helps us to recover a word; that word a sentence; and the first sentence a whole argument. Some have therefore advised, for the assistance of weaker memories, to write each part of the discourse in a separate paragraph, and the first word in larger characters, which may strike the fancy like a picture when we come to those places. For every one is sensible of the powerful effect of imagery to excite and recall our ideas: and therefore it has been thought a further advantage, if the first letter of each word, written in larger characters, could be joined together in one artificial word; for then the remembrance of that word would give us the first letter of each of those initial words, which letters would help us to recollect the whole words, which was the thing designed by writing them in different characters. We find this method of bringing several ideas together into one artificial word of use in other cases. So the figures of syllogisms being distinguished by technical words, are better known, and more easily remembered; as every one perceives, who is conversant in logic.

As the mind is not at all times equally disposed for the exercise of this faculty, such seasons should be made choice of as are most proper for it. The mind is seldom fit for attention presently after meals; and to call off the spirits at such times from their proper employment in digestion, is apt to cloud the brain, and prejudice the health. Both the mind and body should be easy and undisturbed when we engage in this exercise, and therefore retirement is most fit for it: and the evening, just before we go to rest, is generally recommended as a very convenient season, both for the stillness of the night, and because the impressions will then have a longer time to settle before they come to be disturbed by the accession of others proceeding from external objects; and to call over in the morning what has been committed to the memory over-night, must, for the same reason, be very serviceable. For, to review those ideas while they continue fresh upon the mind, and unmixed with any others, must necessarily imprint them more deeply.

Some ancient writers speak of an artificial memory, and lay down rules for attaining it. Simonides the poet is said first to have discovered this, or at least to have given the occasion for it. The story they tell of him is this: Being once at a feast, he recited a poem which he had made in honour of the person who gave the entertainment. But having (as is usual in poetry) made a large digression in praise of Castor and Pollux; when he had repeated the whole poem, his patron would give him but half the sum he had promised, telling him he must get the other part from those

thofe deities who had an equal fhare in the honour of his performance. Immediately after, Simonides was told that two young men were without, and muft needs fpeak with him. He had fcarce got out of the houfe, when the room where the company was fell down, killed all the perfons in it, and fo mafhed their bodies, that, when the rubbifh was thrown off, they could not be known one from another: upon which Simonides recollecting the place where every one had fat, by that means diftinguifhed them. Hence it came to be obferved, that to fix a number of places in the mind in a certain order, was a help to the memory: As we find by experience, that, upon returning to places once familiar to us, we not only remember them, but likewife many things we both faid and did in them. This action therefore of Simonides was afterwards improved into an art, and the nature of it is this: They bid you form in your mind the idea of fome large place or building, which you may divide into a great number of diftinct parts, ranged and difpofed in a certain order. Thefe you are frequently to revolve in your thoughts, till you are able to run them over one after another without hefitation, beginning at any part. Then you are to imprefs upon your mind as many images of living creatures, or any other fenfible objects which are moft likely to affect you, and be fooneft revived in your memory. Thefe, like characters in fhort-hand, or hieroglyphics, muft ftand to denote an equal number of other words, which cannot fo eafily be remembered. When therefore you have a number of things to commit to memory in a certain order, all that you have to do is, to place thefe images regularly in the feveral parts of your building. And thus they tell you, that, by going over feveral parts of the building, the images placed in them will be revived in the mind; which of courfe will give you the things or words themfelves in the order you defire to remember them. The advantages of the images feems to be this; that, as they are more like to affect the imagination than the words for which they ftand, they will for that reafon be more eafily remembered. Thus, for inftance, if the image of a *lion* be made to fignify *ftrength*, and this word *ftrength* be one of thofe I am to remember, and is placed in the porch; when in going over the feveral parts of the building I come to the porch, I fhall fooner be reminded of that image than of the word *ftrength*. Some ancient as well as modern writers relate wonderful effects of this artifice. But they all agree it much more affifts us to remember any number of feparate and unconnected words, than a continued difcourfe; unlefs fo far as the remembrance of one word may enable us to recollect more. And in this refpect it does not much differ from fome of thofe methods above-mentioned as helps to the memory. Quintilian therefore, though he does not wholly pafs it over, yet feems to lay no great ftrefs upon it.

And, doubtlefs, the moft effectual way to gain a good memory is, its conftant and moderate exercife. —In a word, the memory, like other habits, is ftrengthened and improved by daily ufe and practice. Wherefore thofe who have moft occafion for it, as orators, fhould not fuffer it to lie idle, but conftantly employ it in treafuring up and frequently reviewing fuch things as may be of moft importance to them.— For by this means it will be more at their command, and they may put greater confidence in it upon any emergent occafion.

Another method of affifting the memory, is by forming certain words, the letters of which fhall fignify the date or æra to be remembered. In order to this, the following feries of vowels, diphthongs, and confonants, together with their correfponding numbers, muft be exactly learned; fo as to be able at pleafure to form a technical word that fhall ftand for any number, or to refolve fuch a word already formed.

a	*e*	*i*	*o*	*u*	*a*	*oi*	*ei*	*ou*	*y*
1	2	3	4	5	6	7	8	9	0
b	*d*	*t*	*f*	*l*	*s*	*p*	*k*	*n*	*z*

The firft five vowels, in order, naturally reprefent 1, 2, 3, 4, 5; the diphthong *au*=6, as being compofed of *a* and *u*, or 1+5=6; and for the like reafon, *oi*=7, and *ou*=9. The diphthong *ei* will eafily be remembered for 8, as being the initials of the word. In like manner, where the initial confonants could conveniently be retained, they are made ufe of to fignify the number, as *t* for 3, *f* for 4, *s* for 6, and *n* for 9. The reft were affigned without any particular reafon, unlefs that poffibly *p* may be more eafily remembered for 7 or *feptem*, *k* for 8 or ὀκτω, *d* for 2 or *duo*; *b* for 1, as being the firft confonant; and *l* for 5, being the Roman letter for 50, than any others that could have been put in their places.

It is to be farther obferved, that *z* and *y* being made ufe of to reprefent the cypher, where many cyphers meet together, as 1000, 1000000, &c. inftead of a repetition of *a z y z y z y*, &c. let *g* ftand for 100, *th* for a thoufand, and *m* for a million. Thus *ag* will be 100, *ig* 300, *oug* 900, &c. *ath* 1000, *am* 1000000, *loum* 59000000, &c.

Fractions may be fet down in the following manner: let *r* fignify the line feparating the numerator and denominator, the firft coming *before*, the other *after* it; as *iro* $\frac{3}{4}$, *urp* $\frac{5}{7}$, *pourag* $\frac{79}{100}$, &c. When the numerator is 1 or unit, it need not be expreffed, but begin the fraction with *r;* as *re* $\frac{1}{2}$, *ri* $\frac{1}{3}$, *ro* $\frac{1}{4}$, &c. So in decimals, *rag* $\frac{1}{100}$, *rath* $\frac{1}{1000}$.

This is the principal part of the method which confifts in expreffing numbers by artificial words. The application to hiftory and chronology is alfo performed by artificial words. The art herein confifts in making fuch a change in the ending of the name of a place, perfon, planet, coin, &c. without altering the beginning of it, as fhall readily fuggeft the thing fought, at the fame time that the beginning of the word, being preferved, fhall be a leading or prompting fyllable to the ending of it fo changed. Thus, in order to remember the years in which Cyrus, Alexander, and Julius Cefar, founded their refpective monarchies, the following words may be formed; for Cyrus, Cyr*uts;* for Alexander, Alex*ita;* for Julius Cefar, Juli*os*. *Uts* fignifies, according to the powers affigned to the letters before-mentioned, 536; *ita* is 331, and *os* is 46. Hence it will be eafy to remember, that the empire of Cyrus was founded 536 years before Chrift, that of Alexander 331, and that of Julius Cefar 46. This account is taken from a treatife, entitled *A New Method of Artificial Memory;* where the reader will find feveral

ral examples in chronology, geography, &c. of ſuch artificial words diſpoſed in verſes, which muſt be allowed to contribute much to the aſſiſtance of the memory, ſince being once learned they are ſeldom or never forgot. However, the author adviſes his reader to form the words and verſes himſelf, in the manner deſcribed above, as he will probably remember theſe better than thoſe formed by another.

We ſhall here give his table of the kings of England ſince the conqueſt; where 1000 being added to the italics in each word, expreſſes the year when they began their reigns. Thus,

Will-con*ſau*, Ruf*koi*, Hen*rag*.
Steph*il* & Henfec*kuf*, Rich*bein*, *Jann*, Heth*das* & Edd*oid*
Edſe*typ*, Edtar*tep*, Riſe*tois*, Hefo*toun*, Heti*fadque*.
Hen*ſifed*, Edquar*fauz*, Efi R*okt*, Henſep*feil*, Henoc*lyn*.
Edſex*los*, Mary*lut*, Els*luk*, Jam*ſyd*, Caroprim*ſel*.
Carſec*ſok*, Jam*ſeif*, Wil*ſeik*, An*pyd*, Geo*bo-doi*.

MEMPHIS, an ancient city, and the royal reſidence of the kings in the Higher Egypt; diſtant from the Delta to the ſouth 15 miles, according to Pliny. Situate on the weſt ſide of the Nile, over-againſt Babylon. Famous for its pyramids, the burial-places of the kings. In Strabo's time it was flouriſhing and populous, and ſecond to Alexandria. Called alſo *Moph* and *Noph*, in ſcripture.

MENAGE (Giles), in Latin *Ægidius*, a celebrated French writer, born at Angers in 1613. He finiſhed his ſtudies in that city, was made advocate, and pleaded for ſome time at Angers, Paris, and Poictiers; but, becoming at length diſguſted with the bar, turned eccleſiaſtic, and gave himſelf up entirely to the ſtudy of polite literature. He at length entered into the family of the cardinal de Retz; but diſagreeing with ſome perſons belonging to his eminence, went to live in the cloyſter of Notre Dame, where he held an aſſembly of learned men every Wedneſday. He read a great deal; had a prodigious memory; and was inceſſantly quoting in his converſation, verſes in Greek, Latin, Italian, French, &c. on which account he was often turned into ridicule by the wits, eſpecially towards the end of his days. His great memory he retained even in his old age; and what is very rare, it returned to him after ſome interruption. The reputation of his works procured him a place in the academy *della Cruſca* at Florence. He might have been a member of the French academy at its firſt inſtitution, if it had not been for his *Requeſte des Dictionnaires*: but when that was forgot, he was propoſed in 1684 to fill up a vacant place in that academy, and was excluded only by the ſuperior intereſt of his competitor Mr Bergent; for there was not one member of all thoſe who gave their votes againſt him, but owned that he deſerved the place. He would not ſuffer his friends to propoſe him again. He died at Paris in 1692, aged 79. He wrote a great number of books in proſe and verſe; the principal of which are, 1. Miſcellaneous works. 2. The Origin of the French Language. 3. The Origin of the Italian Tongue; the beſt edition of which is that of Geneva, in 1685, folio. 4. An edition of Malherbe's Poems, with Notes. 5. An edition of Diogenes Laertius, with Obſervations. 6. Remarks on the French Tongue. 7. Greek, Latin, Italian, and French poems.

MENANDER, an ancient Greek poet, was born at Athens in the ſame year with Epicurus, which was the third of the 109th olympiad. His happineſs in introducing the new comedy, and refining an art which had been ſo groſs and licentious in former times, quickly ſpread his name over the world. Pliny informs us, that the kings of Egypt and Macedon gave a noble teſtimony of his merit, by ſending ambaſſadors to invite him to their courts, and even fleets to bring him over; but that Menander was ſo much of a philoſopher, as to prefer the free enjoyment of his ſtudies to the promiſed favours of the great. Of his works, which amounted to above 100 comedies, we have had a double loſs, the originals being not only vaniſhed, but the greateſt part of them, when copied by Terence, having unfortunately periſhed by ſhipwreck before they ſaw Rome. Yet the four plays which Terence borrowed from him before that accident happened, are ſtill preſerved in the Roman habit; and it is chiefly from Terence that moſt people form their judgment of Menander, the fragments that remain of him not being ſufficient to enable them to do it. The ancients have ſaid high things of Menander; and we find the old maſters of rhetoric recommending his works, as the true patterns of every beauty and every grace of public ſpeaking. Quintilian declares, that a careful imitation of Menander only, will ſatisfy all the rules he has laid down in his Inſtitutions. It is in Menander that he would have his orator ſearch for a copiouſneſs of invention, for a happy elegance of expreſſion, and eſpecially for that univerſal genius which is able to accommodate itſelf to perſons, things, and affections.

But Julius Ceſar has left the loftieſt as well as the juſteſt praiſe of Menander's works, when he calls Terence only a *Half-Menander*. For while the virtues of the Latin poet are ſo deſervedly admired, it is impoſſible we ſhould raiſe a higher notion of excellency, than to conceive the great original ſtill ſhining with half its luſtre unreflected, and preſerving an equal part of its graces, above the power of the beſt copier in the world.

Menander died in the 3d year of the 122d olympiad, as we are taught by the ſame old inſcription from which we learn the time of his birth. His tomb, in Pauſanias's age, was to be ſeen at Athens, in the way from the Piræus to the city, cloſe by the honorary monument of Euripides. Quintilian, in his judgment of Afranius the Roman comedian, who imitated him, cenſures Menander's morals as much as he commends his writings; and his character, according to Suidas, is, that he was a very "mad fellow after women." Phædrus has given him the gait and dreſs of a moſt affected fop:

"Unguento delibutus, veſtitu adfluens,
"Veniebat greſſu delicatulo & languido."
Lib. v. fab. 2.

MENASSEH (Ben Iſrael), a celebrated rabbi, born in Portugal about the year 1604, was the ſon of Joſeph Ben Iſrael, and followed his father into Holland, where he was educated by rabbi Iſaac Uziel, under whom, he in a ſhort time made ſuch progreſs in the Hebrew tongue, that at 18 years of age he ſucceeded him in the ſynagogue of Amſterdam, in which poſt he continued ſeveral years, and married Rachel of the family of the Abarbanels, whom the Jews imagine to be deſcended from king David. He afterwards

went

went to his brother Ephraim, a rich merchant, who had fettled at Bafil; by whofe advice he entered into trade. Some time after, the hopes of a more agreeable fettlement induced him to come into England, under the protectorfhip of Cromwell; who gave him a very favourable reception, and one day entertained him at his table with feveral other learned divines. However, he foon after paffed into Zealand; and died at Middleburg about the year 1657. The Jews at Amfterdam obtained his body, and interred it at their expence. He was of the fect of the Pharifees; had a lively wit, a folid judgment, great learning, and all the virtues that can adorn private life. He wrote many works in Hebrew, Latin, Spanifh, and Englifh. The principal of thofe publifhed in Latin, are, 1. His *Conciliator;* a learned and curious work, in which he reconciles thofe paffages of Scripture which feem to contradict each other. 2. *De refurrectione mortuorum.* 3. *De termino vitæ.* 4. *Differtatio de fragilitate humana, ex lapfu Adami, deque Divino in bono opere auxilio.* 5. *Spes Ifrael.* Dr Thomas Pococke has written his life in Englifh.

MENCKE (Lewis Otto), in Latin *Menckenius*, a learned profeffor of morality at Leipfic, was born at Oldenburg in Weftphalia in 1644. He ftudied in feveral univerfities of Germany; and became an able philofopher, civilian, and divine. He was made profeffor of morality at Leipfic in 1668; and enjoyed that poft to his death. He was five times rector of the univerfity of that city, and feven times dean of the faculty of philofophy. He publifhed feveral works; but his moft confiderable, and what alone is fufficient to perpetuate his memory, is the *Acta Eruditorum* of Leipfic, of which he was the firft author, and in which he was engaged till his death. The firft volume was publifhed at Leipfic, in 4to, in 1682.

MENCKE (John Burchard), fon to the preceding. After his ftudies he travelled into England and Holland; and upon his return was appointed profeffor of hiftory at Leipfic in 1699. He gained great reputation by his lectures as well as his writings.. He died in 1732, aged 58. He wrote many pieces. His *De Charlataneriâ eruditorum declamationes duæ*, is an excellent fatire, defigned to expofe the artifices ufed by falfe fcholars to raife themfelves a name. As he named and pointed at certain perfons, it exafperated them, and they procured his book to be feized; but it fpread, and editions of it were multiplied. He likewife publifhed *Methode pour étudier l'Hiftoire, avec un catalogue des principaux hiftoriens*, &c. He made a great many additions to Mr Lenglet's book, efpecially with regard to the German hiftorians.

MENDICANTS, or BEGGING FRIARS, feveral orders of religious in Popifh countries, who having no fettled revenues, are fupported by the charitable contributions they receive from others.

This fort of friars began in the 13th century. The Waldenfes, who made profeffion of renouncing their eftates, and leading a life of poverty, gave occafion to this inftitution. Two of that fect, Bernard and Durand of Ofca, fet up a congregation in the province of Tarragon, and called it *The Poor Catholics*. The fame year, Dominick de Guzman, with nine more of his companions, founded the order of Preaching Friars, called from their founder *Dominicans*. The other three Mendicant orders are, the *Francifcans*, *Auguftins*, and *Carmelites*.

"A great many have embraced this fevere order, (fays Puffendorf), out of an opinion of a particular holinefs and merit which they believed did belong to it, or rather an ecclefiaftic ambition; the pride of mankind being fo great and natural to fome, that they did not think the commands of God fufficient, but would receive heaven rather as a defert than a gift, and were ambitious of having a preference before others even in another life."

Buchannan tells us, the Mendicants in Scotland, under an appearance of beggary, lived a very luxurious life; whence one wittily called them, not *Mendicant*, but *Manducant*, friars.

MENDOZA (Juan Gonzales de), an Auguftan friar, of the province of Caftile, was made ambaffador from the king of Spain to the emperor of China. In 1593, he was made bifhop of Liperi in Italy. In 1607 he was made bifhop of Chiapa in New Spain, and the next year was removed to the fee of Papaian in the Weft Indies. He wrote a hiftory of China in Spanifh, which has been tranflated into feveral languages.

MENECRATES, a phyfician of Syracufe, who flourifhed about 360 B. C. is famous for his fkill in his profeffion, but much more for his vanity. He would always be followed by fome of the patients whom he had cured, one dreffed like Apollo, another like Efculapius, a third like Hercules, &c. As for himfelf, he would be called *Jupiter*. He wrote a letter to Philip the father of Alexander the Great, with this fuperfcription, "Menecrates Jupiter to king Philip, Health:" When that prince ridiculed him by replying, "Philip to Menecrates, Health and Good Senfe." Menecrates compofed a book of *Remedies*, which is loft.

MENEDEMUS, a Greek philofopher, born at Erythreum, was the fon of Califthenes, and one of Phedo's followers. He was in greaft efteem, and enjoyed feveral important pofts in his own country. He feveral times defended Erythreum with great bravery, and died of grief when Antigonus became mafter of it. A perfon one day faying to him, "It is a great happinefs to have what we defire," he replied, "It is a much greater to defire nothing but what we have." He flourifhed about 300 B. C.

MENELAUS, the fon of Atreus, and the brother of Agamemnon, reigned at Sparta, when Paris deprived him of his wife Helen. This rape occafioned the famous war of Troy. See HELEN.

MENELAUS, a mathematician in the reign of the emperor Trajan, wrote three books on the *Sphere*, which have been publifhed by father Merfenne.

MENES, born at This, a town of Thebais in Upper Egypt, was the founder of the Egyptian empire. He had three fons, viz. Athotis, who ruled after him at This and Thebes; Curudes, who, in Lower Egypt founded the kingdom of Heliopoli, which afterward was the kingdom of Diofpoli; and Necherophes, who reigned at Memphis. It is thought this Menes reigned 117 years after the birth of Phaleg, fon of Heber, which was the very year of the difperfion of the people throughout the whole earth. In building Memphis, he ftopped the Nile near it, by the invention of a

MENE-

causeway 100 furlongs broad, and caused it to run thro' the mountains.

MENESTRIER (John Baptift le), a native of Dijon, and one of the moft learned and curious French antiquaries of his time, wrote, 1. A treatife on the medals, money, and ancient monuments of the Roman empreffes, in folio. 2. The moft famous medals of the ancient Roman emperors and empreffes, in quarto. He died in 1634, aged 70.

MENGRELIA, a province of Turky in Afia. See MINGRELIA.

MENIALS, domeftic or houfehold fervants, who live under their lord or mafter's roof.

MENINGES, or MENYNGES, in anatomy, a name given to the dura and pia mater of the brain. See ANATOMY, n° 394.

MENINX, an ifland in the Mediterranean, to the weft of the Syrtis Minor. Suppofed by Strabo and Polybius to be Homer's country of the Lotophagi; and hence Ptolemy and Eratofthenes denominate the ifland *Lotophagitis*, with a cognominal town *Meninx*. The country of Vibius Gallus the emperor, and of Volufianus. Now called *Gerbi* and *Zarbi*.

MENISPERMUM, MOONSEED; a genus of the decandria order, belonging to the diœcia clafs of plants. There are three fpecies, all of them climbing plants, rifing 14 feet high, and natives of warm climates; but noway remarkable for beauty. The feeds of a kind which grows in the Levant, being formed into a pafte, are regarded by the inhabitants as fpecific againft lice and cutaneous eruptions. The fame pafte is likewife ufed for the purpofe of intoxicating fifhes.

MENOCHIUS, vulgarly MENOCHIA, (James), a famous lawyer, meanly born at Pavia, but who became fo fkilful in the law, that he was called the *Baldus* and *Bartholus* of his age; all the princes of Italy foliciting him to their univerfities. He read at Padua 23 years together; and for love of his country removed to Pavia, and fucceeded Nicholas Gratiani. He hath got an immortal fame by his works, *De recuperanda poffeffione; De adipifcenda poffeffione; De præfumtionibus; De arbitrariis Judicum queftionibus & caufis conciliorum*, tom. 13. &c. He died in 1607, aged 75.

MENNITH, or MINNITH, Judges xi. 33. a town near Hefhbon, (Jerome), in Arabia Petræa; in a diftrict named *Ecofipolis*, or *twenty-towns*, (Cellarius). There is alfo a Minnith mentioned Ezekiel xxvii. as being in a good wheat country: but whether the fame with the foregoing is uncertain; though fome think, that the firft Minnith lay in the country of Ammon, (Wells).

MENNONITES, a fect of baptifts in Holland, fo called from Mennon Simonis of Friezeland, who lived in the 16th century. This fect believe, that the New Teftament is the only rule of faith; that the terms *Perfon* and *Trinity* are not to be ufed in fpeaking of the Father, Son, and Holy Ghoft; that the firft man was not created perfect; that it is unlawful to fwear or to wage war upon any occafion; that infants are not the proper fubjects of baptifm; and that minifters of the gofpel ought to receive no falary. They all unite in pleading for toleration in religion, and debar none from their affemblies who led pious lives, and own the fcriptures for the word of God. The Mennonites meet privately; and every one in the affembly has the liberty to fpeak, to expound the fcriptures, to pray and fing. They affemble twice every year, from all parts of Holland, at Rynfbourg, a village about two leagues from Leyden; at which time they receive the communion, fitting at a table, where the firft diftributes to the reft; and all fects are admitted, even the Roman Catholics, if they pleafe to come.

MENOLOGY, the Greek calendar, in which the lives of the faints in fhort, or barely their names, are cited; anfwering nearly to the MARTYROLOGY of the Latin church.

MENSA, in law-books, a term that includes in it all patrimony, and neceffaries for livelihood.

MENSALS, MENSALIA, in church-hiftory, fuch livings as were formerly united to the tables of religious houfes, and hence called *menfal benefices*. See the article BENEFICE.

MENSES, FLUORS, *Courfes*, *Catamenia*, in medicine, the monthly evacuations from the uterus of women not with child and not giving fuck.

With regard to the caufes of this evacuation, the beft phyfiologifts are entirely at a lofs.. It was long difputed whether the menftrual blood flowed from the uterus or vagina, but fome obfervations of retroverted uteri have determined in favour of the former opinion. —For the diforders which follow a fuppreffion, or too great a flow of the menfes, fee MEDICINE, n° 488, 259—264. and p. 4871.

MENSTRUUM, in chemiftry, any body which in a fluid or fubtilifed ftate is capable of interpofing its fmall parts betwixt the fmall parts of other bodies, fo as to divide them fubtilly, and form a new uniform compound of the two.

MENSURATION, in general, denotes the act or art of meafuring lines, fuperficies, or folids. See GEOMETRY.

MENTHA, MINT; a genus of the gymnofpermia order, belonging to the didynamia clafs of plants. There are many fpecies; but not more than three are cultivated for ufe, namely, the viridis or common fpearmint, the piperita or peppermint, and the pulegium or pennyroyal. All thefe are fo well known as to need no defcription; and all of them are very eafily propagated by cuttings, parting the roots, or by offsets.

Ufes. For culinary purpofes, the fpearmint is preferable to the other two; but for medicine, the peppermint and pennyroyal have in fome places almoft entirely fuperfeded it. A conferve of the leaves is very grateful, and the diftilled waters both fimple and fpirituous are univerfally thought pleafant. The leaves are ufed in fpring fallads; and the juice of them boiled up with fugar is formed into tablets. It has been imagined that cataplafms and fomentations of mint, would diffolve coagulations of milk in the breafts; but Dr Lewis fays, that the curd of milk, digefted in a ftrong infufion of mint, could not be perceived to be any otherwife affected than by common water: however, milk in which mint-leaves were fet to macerate, did not coagulate near no foon as an equal quantity of the fame milk kept by itfelf. Dr Lewis fays, that dry mint digefted in rectified fpirits of wine, gives out a tincture, which appears by day-light of a fine dark green,

green, but by candle-light of a bright red colour. The fact is, that a small quantity of this tincture is green either by day-light or by candle-light, but a large quantity of it seems impervious to common day-light; however, when held betwixt the eye and a candle, or betwixt the eye and the sun, it appears red.

The virtues of mint are those of a warm stomach and carminative: in loss of appetite, nausea, and continual reaching to vomit, there are few simples of equal efficacy. In colicky pains, the gripes to which children are subject, lienteries, and other immoderate fluxes, this plant frequently does good service. It likewise proves beneficial in many hysteric cases, and affords an useful cordial in languors and other weaknesses consequent upon delivery. The best preparation in these cases is a strong infusion of the dried herb in water, (which is much superior to the green), or rather a tincture or extract prepared with rectified spirit. These possess the whole virtues of the mint; the essential oil and distilled water contain only the aromatic part; the expressed juice only the astringency and bitterishness, together with the mucilaginous substance common to all vegetables. The peppermint is much more pungent than the others.

Pennyroyal has the same general characters with the mint, but is more acrid and less agreeable when taken into the stomach. It has long been held in great esteem, and not undeservedly, as an aperient and deobstruent, particularly in hysteric complaints and suppressions of the menses. For these purposes the distilled water is generally made use of, or, what is of equal efficacy, an infusion of the leaves. It is observable, that both water and rectified spirit extract the virtues of this herb by infusion, and likewise elevate the greatest part of them by distillation. The expressed juice with a little sugar, is not a bad medicine in the chincough.

MENTZ, an archbishopric and electorate in Germany. It lies on the banks of the river Mayne, between the electorate of Triers on the west, the Palatinate on the south, Franconia on the east, and the Wetteraw on the north. It is about 60 miles in length from north-east to south-west, and about 50 in breadth. A considerable part of the elector's revenue arises from the toll on the Rhine and the Mayne, and from the tax on the excellent wines produced in this country. The chief towns of any trade are, 1. Mentz, on the Rhine, near its confluence with the Mayne. This city claims a right to the invention of the art of printing, (see *History* of PRINTING.) Here is a very beautiful quay along the river, defended by several works well fortified with cannon. That part of the city which extends towards the river is most populous. The best vineyards for Rhenish wine being in this neighbourhood, Mentz has a flourishing trade in that commodity more particularly; and its commerce is the brisker, by reason that all the merchandize which passes up and down the Rhine stops in its harbour to change bottoms. In this neighbourhood is Hockhem, so celebrated for good wines, that the best Rhenish is from thence called *old hock*. 2. Bingen is a pleasant small town, which stands in the district called *Rhingaw*, which is so populous, that it looks like one entire town, intermixed with gardens and vinegards. The rising grounds about it produce wines that are esteemed preferable to those of Baccharac, so much in vogue heretofore. 3. Elfeld, five miles west from Mentz, is a strong fortified town, on the north side of the Rhine, and the chief of the Rhingaw.—Here is Roderheim, a place noted for the growth of the best wines in these parts. 4. Weisbaden lies between six and seven leagues from Frankfort, and about five or six miles north of Mentz: it is the metropolis of a country belonging to the branch of Nassau-Saarbrack, and is famous for its mineral waters.

MENYANTHES, MARSH-TREFOIL, or *Buckbean*; a genus of the monogynia order, belonging to the pentandria class of plants. This plant grows wild in moist marshy places in many parts of Britain. It has three oval leaves standing together upon one pedicle, which issues from the root; their taste is very bitter, and somewhat nauseous. According to Mr Lightfoot, the flowers of this plant are so extremely beautiful, that nothing but their native soil could exclude it from a place in every garden. They grow in an elegant spike; are white, dashed with pink, and fringed internally with hairs. The highlanders esteem an infusion or tea of the leaves as good to strengthen the stomach. According to Mr Withering, an infusion of the leaves is prescribed in rheumatisms and dropsies; a dram of them in powder purges and vomits, and is sometimes given to destroy worms. In a scarcity of hops, the plant is used in the north of Europe to bitter the ale. The powdered roots are sometimes used in Lapland instead of bread, but they are unpalatable. Some people say, that sheep will eat it, and that it cures them of the rot; but from the Upsal Experiments it appears, that though goats eat it, sheep sometimes will not. Cows, horses, and swine, refuse it.—As to its medical virtues, Dr Lewis informs us, that it is an efficacious aperient and deobstruent; promotes the fluid secretions; and, if liberally taken, gently loosens the belly. It has of late gained great reputation in scorbutic and scrophulous disorders; and its good effects in those cases have been warranted by experience. Inveterate cutaneous diseases have been removed by an infusion of the leaves, drank to the quantity of a pint a-day, at proper intervals, and continued for some weeks. Boerhaave relates, that he was relieved of the gout by drinking the juice mixed with whey.

MENZINI (Benedict), a celebrated Italian poet, born at Florence, was professor of eloquence at the college Della Sapienza at Rome, where he died in 1704. He wrote, 1. The art of poetry. 2. Satires, elegies, hymns, and the Lamentations of Jeremiah. 3. *Academia Tusculana*, a work in verse and prose, which passes for his masterpiece.

MEOTIS, or PALUS MEOTIS, a sea of Turky, which divides Europe from Asia; extending from Crim Tartary to the mouth of the river Don or Tanais.

MEPHITIC, a name expressing any kind of noxious vapour; but generally applied to that species of vapour called *fixed air*. See AIR, FIXED *Air*, GAS, *&c.*

MERCATOR (Gerard), one of the most celebrated geographers of his time, was born at Ruremonde in 1512. He applied himself with such industry

dustry to geography and mathematics, that he is said to have frequently forgot to eat and drink. The emperor Charles V. had a particular esteem for him, and the duke of Juliers made him his cosmographer. He composed a chronology, some geographical tables, an Atlas, &c. engraving and colouring the maps himself. He died in 1594. His method of laying down charts is still used, and bears the name of *Mercator's charts*.

MERCATOR (Nicholas), an eminent mathematician in the 17th century, was born at Holstein in Denmark; and came to England about the time of the restoration, where he lived many years. He was fellow of the Royal Society; and endeavoured to reduce astrology to rational principles, as appeared from a MS. of his in the possession of William Jones, Esq; He published several works, particularly *Cosmographia*. He gave the quadrature of the hyperbole by an infinite series; which was the first appearance in the learned world of a series of this sort drawn from the particular nature of the curve, and that in a manner very new and abstracted.

MERCATOR's *Sailing*, that performed by Mercator's chart. See NAVIGATION.

MERCHANT, a person who buys and sells commodities in gross, or deals in exchanges; or that traffics in the way of commerce, either by importation or exportation. Formerly every one who was a buyer or seller in the retail way was called a *merchant*, as they still are both in France and Holland; but here shopkeepers, or those who attend fairs or markets, have lost that appellation.

Previous to a person's engaging in a general trade, and becoming an universal dealer, he ought to treasure up such a fund of useful knowledge, as will enable him to carry it on with ease to himself, and without risking such losses as great ill-concerted undertakings would naturally expose him to. A merchant should therefore be acquainted with the following parts of commercial learning. 1. He should write properly and correctly. 2. Understand all the rules of arithmetic that have any relation to commerce. 3. Know how to keep books of double and single entry, as journals, a leger, &c. 4. Be expert in the forms of invoices, accounts of sales, policies of insurance, charter-parties, bills of lading, and bills of exchange. 5. Know the agreement between the money, weights and measures of all parts. 6. If he deals in silk, woollen, linnen, or hair manufactures, he ought to know the places where the different sorts of merchandizes are manufactured, in what manner they are made, what are the materials of which they are composed, and from whence they come, the preparations of these materials before working up, and the places to which they are sent after their fabrication. 7. He ought to know the lengths and breadths which silk, woollen, or hair-stuffs, linen, cottons, fustians, &c. ought to have according to the several statutes and regulations of the places where they are manufactured, with their different prices, according to the times and seasons; and if he can add to his knowledge the different dyes and ingredients which form the various colours, it will not be useless. 8. If he confines his trade to that of oils, wines, &c. he ought to inform himself particularly of the appearances of the succeeding crops, in order to regulate his disposing of what he has on hand; and to learn as exactly as he can, what they have produced when got in, for his direction in making the necessary purchases and engagements. 9. He ought to be acquainted with the sorts of merchandize found more in one country than another, those which are scarce, their different species and qualities, and the properest method for bringing them to a good market either by land or sea. 10. To know which are the merchandizes permitted or prohibited, as well on entering as going out of the kingdoms or states where they are made. 11. To be acquainted with the price of exchange, according to the course of different places, and what is the cause of its rise and fall. 12. To know the customs due on importation or exportation of merchandizes, according to the usage, the tarifs, and regulations, of the places to which he trades. 13. To know the best manner of folding up, embaling, or tunning, the merchandizes for their preservation. 14. To understand the price and condition of freighting and insuring ships and merchandize. 15. To be acquainted with the goodness and value of all necessaries for the construction and repairs of shipping, the different manner of their building; what the wood, the masts, cordage, cannons, sails, and all requisites, may cost. 16. To know the wages commonly given to the captains, officers, and sailors, and the manner of engaging with them. 17. He ought to understand the foreign languages, or at least as many of them as he can attain to; these may be reduced to four, viz. the Spanish, which is used not only in Spain, but on the coast of Africa, from the Canaries to the Cape of Good Hope: the Italian, which is understood on all the coasts of the Mediterranean, and in many parts of the Levant: the German, which is understood in almost all the northern countries; and the French, which is now become almost universally current. 18. He ought to be acquainted with the consular jurisdiction, with the laws, customs, and usages of the different countries he does or may trade to; and in general all the ordinances and regulations both at home and abroad that have any relation to commerce. 19. Though it is not necessary for a merchant to be very learned, it is proper that he should know something of history, particularly that of his own country; geography; hydrography, or the science of navigation; and that he be acquainted with the discoveries of the countries in which trade is established, in what manner it is settled, of the companies formed to support those establishments, and of the colonies they have sent out.

All these branches of knowledge are of great service to a merchant who carries on an extensive commerce; but if his trade and his views are more limited, his learning and knowledge may be so too: but a material requisite for forming a merchant is, his having on all occasions a strict regard to truth, and his avoiding fraud and deceit as corroding cankers that must inevitably destroy his reputation and fortune.

Trade is a thing of so universal a nature, that it is impossible for the laws of Britain, or of any other nation, to determine all the affairs relating to it: therefore all nations, as well as Great Britain, shew a particular regard to the *law-merchant*, which is a law made by the merchants among themselves: however, merchants and other strangers are subject to the laws of

Merchet, Mercia.

of the country in which they refide. Foreign merchants are to fell their merchandize at the port where they land, in grofs, and not by retail; and they are allowed to be paid in gold or filver bullion, in foreign coin or jewels, which may be exported. If a difference arifes between the king and any foreign ftate, the merchants of that ftate are allowed fix months time to fell their effects and leave the kingdom; during which time they are to remain free and unmolefted in their perfons and goods. See the articles COMMERCE, and *Mercantile* LAW.

MERCHET (MERCHETUM), a fine or compofition paid by inferior tenants to the lord, for liberty to difpofe of their daughters in marriage. No baron, or military tenant, could marry his fole daughter and heir, without fuch leave purchafed from the king, *pro maritanda filia*. And many of our fervile tenants could neither fend their fons to fchool, nor give their daughters in marriage, without exprefs leave from the fuperior lord. See Kennet's Gloffary *in Maritagium*. See alfo MARCHET.

MERCIA, the name of one of the feven kingdoms founded in England by the Saxons. Though the lateft formed, it was the largeft of them all, and grew by degrees to be by far the moft powerful. On the north it was bounded by the Humber and the Merfey, which feparated it from the kingdom of Northumberland; on the eaft by the fea, and the territories of the Eaft-Angles and Saxons; on the fouth by the river Thames; and on the weft by the rivers Severn and Dee. It comprehended well nigh 17 of our modern counties, being equal in fize to the province of Languedoc in France; very little, if at all, lefs than the kingdom of Arragon in Spain; and fuperior in fize to that of Bohemia in Germany.

Penda is regarded as its firft monarch; and the kingdom is thought to derive its name from the Saxon word *merc*, which fignifies a *march*, *bound*, or *limit*, becaufe the other kingdoms bordered upon it on every fide; and not from the river Merfey, as fome would perfuade us. Penda affumed the regal title A. D. 626, and was of the age of 50 at the time of his acceffion; after which he reigned near 30 years. He was of a moft furious and turbulent temper, breaking at different times with almoft all his neighbours, calling in the Britons to his affiftance, and fhedding more Saxon blood than had been hitherto fpilled in all their inteftine quarrels. He killed two kings of Northumberland, three of the Eaft-Angles, and compelled Kenwall king of the Weft-Saxons to quit his dominions. He was at length flain, with moft of the princes of his family, and a multitude of his fubjects, in a battle fought not far from the Leeds, by Ofwy king of Northumberland. This battle, which the Saxon chronicle tells us was fought at Winwidfield, A. D. 655, made a great change in the Saxon affairs, which the unbridled fury of Penda had thrown into great confufion. He had the year before killed Anna king of the Eaft-Angles in battle, whofe brother Ethelred notwithftanding took part with Penda. On the other hand, Peada the eldeft fon of Penda, to whom his father had given the ancient kingdom of the Mid-Angles, had two years before married the natural daughter of king Ofwy, and had been baptized at his court. At that time it fhould feem that Ofwy and Penda were upon good terms; but after the latter had conquered the Eaft-Angles, he refolved to turn his arms againft the kingdom of Northumberland. Ofwy by no means had provoked this rupture; on the contrary, Bede tells us that he offered large fums of money, and jewels of great value, to purchafe peace: thefe offers being rejected, he was reduced to the neceffity of deciding the quarrel by the fword. The river near which the battle was fought overflowing, there were more drowned than killed. Amongft thefe, as the Saxon chronicle fays, there were 30 princes of the royal line, fome of whom bore the title of *kings;* and alfo Ethelred king of the Eaft-Angles, who fought on the fide of Penda againft his family and country.

Mercia.

His fon Peada, who married the daughter of that conqueror, became a Chriftian, and was not long after murdered as is faid by the malice of his mother. His brother Wolfher becoming king of Mercia, embraced in procefs of time the faith of the Gofpel, and proved a very victorious and potent monarch; and is, with no fewer than feven of his immediate fucceffors, commonly ftyled *king of the Anglo-Saxons*, though none of them are owned in that quality by the Saxon chronicle. But though poffibly none of them might enjoy this honour, they were undoubtedly very puiffant princes, maintaining great wars, and obtaining many advantages over the fovereigns of other Saxon ftates, and efpecially the Eaft-Angles, whom they reduced. The extent of the Mercian territories was fo ample as to admit, and fo fituated as to require, the conftituting fubordinate rulers in feveral provinces; to whom, efpecially if they were of the royal line, they gave the title of *kings;* which occafions fome confufion in their hiftory. Befides the eftablifhing epifcopal fees and convents, the Saxon monarchs took other methods for improving and adorning their dominions; and as Mercia was the largeft, fo thefe methods were moft confpicuous therein. Coventry, as being fituated in the centre, was ufually, but not always, the royal refidence. Penda, who was almoft continually in a ftate of war, lived as his military operations directed, in fome great town on the frontiers. Wolther built a caftle or fortified palace for his own refidence, which bore his name. —Offa kept his court at Sutton Walls near Hereford.

In each of the provinces there refided a chief magiftrate; and if he was of the royal blood, had ufually the title of *king*. Peada, at the time he married Ofwy's daughter, had the title of *king of Leicefter*.—Ethelred made his brother Merowald king of Hereford; who, dying without iffue, bequeathed it to his younger brother Mercelm. The like honours were fometimes conferred upon the princeffes; and hence, in Mercia efpecially, we occafionally read of *vice-queens*. By thefe means the laws were better executed, the obedience of the fubjects more effectually fecured, and the fplendor of thefe refidences conftantly kept up and augmented.

At length, the crown devolving fometimes on minors, and fometimes on weak princes, inteftine factions alfo prevailing, the force of this hitherto mighty kingdom began fenfibly to decline. This falling out in the days of Egbert, the moft prudent as well as the moft potent monarch of the Weft-Saxons, he took advantage of thefe circumftances; and having en-

encouraged the East-Angles to make an attempt for the recovery of their independence, he, in a conjuncture every way favourable to his design, broke with the Mercians, and after a short war obliged them to submit. But this was not an absolute conquest, the kings of Mercia being allowed by him and his successors to retain their titles and dominions, till the the invasion of the Danes put an end to their rule, when this kingdom had subsisted above 250 years; and when the Danes were afterwards expelled by the West-Saxons, it sunk into a province, or rather was divided into many.

MERCURIAL, something consisting of, or relating to, mercury.

MERCURIALIS (Jerom), an eminent Italian physician, born at Forli in 1530, where he first practised; but afterwards was professor of medicine successively at Padua, Bologna, and Pisa. His writings in physic are very numerous; besides giving an edition of Hippocrates in Greek and Latin, with notes, which, however, did not answer the expectations of the learned. He died in 1606; and in 1644 some select pieces of his were published at Venice in one volume folio.

MERCURIALIS, MERCURY; a genus of the enneandria order, belonging to the diœcia class of plants. There are three species. 1. The annua, or French mercury, with spiked flowers, male and female. This is an annual plant, with a branching stalk about a foot high, garnished with spear-shaped leaves of a pale or yellowish green colour. The male plants have spikes of herbaceous flowers, growing on the top of the stalks: these fall off soon; but the female plants, which have testiculated flowers proceeding from the side of the stalks, are succeeded by seeds, which, if permitted to scatter, will produce plenty of plants of both sexes. 2. The perennis, mountain or dog's mercury, with spiked and testiculated flowers, grows under hedges and in woods, in many parts of Britain. This hath a perennial root, which creeps in the ground; the stalks are single, and without branches, rising ten or twelve inches high, garnished with rough leaves, placed by pairs at each joint, of a dark green colour, indented on their edges: these have their male flowers growing in spikes, upon different plants from those which produce seeds. 3. The tomentosa, or shrubby hairy mercury, is a native of the south of France, Spain, and Italy. It hath a shrubby branching stalk, growing a foot and an half high, garnished with oval leaves placed by pairs, and covered with a white down on both sides. The male flowers grow in short spikes from the side of the stalks upon different plants from the first. All the species are easily propagated by seeds, and are apt to become troublesome weeds where they have once got a footing.

Properties. The perennis, according to Mr Lightfoot, is of a soporific deleterious nature, noxious both to man and beast. There are instances of those who have eaten it by mistake instead of chenopodium, bonus Henricus, or English mercury, and have thereby slept their last. In the isle of Skye, it is called *lusglen-bracadale;* and an infusion of it is sometimes taken to bring on a salivation; but our author knows not how the experiment answers. Tournefort informs us, that the French make a syrup of the juice of the annua, two ounces of which is given as a purge; and that they use it in pessaries and clysters, mixing one quantity of honey, to one and a half of the juice. Mr Withering differs greatly from Lightfoot concerning the qualities of the perennis. "This plant, (says he), dressed like spinach, is very good eating early in the spring, and is frequently gathered for that purpose; but it is said to be hurtful to sheep. Mr Ray relates the case of a man, his wife, and three children, who experienced highly deleterious effects from eating it fried with bacon; but this was probably when the spring was more advanced, and the plant become acrimonious. Steeped in water, it affords a fine deep blue colour. Sheep and goats eat it; cows and horses refuse it.

MERCURY, in natural history. See CHEMISTRY, n° 153, 205, 250, 214. See also METALLURGY, and QUICKSILVER.

The use of mercury in medicine seems to have been little known before the 15th century. The ancients looked upon it as a corrosive poison, though of itself perfectly void of acrimony, taste, and smell; there are examples of its having been lodged for years in cavities both of bones and fleshy parts, without its having injured or affected them. Taken into the body in its crude state, and undivided, it passes through the intestines unchanged, and has not been found to produce any considerable effect. It has indeed been recommended in asthmas and disorders of the lungs; but the virtues attributed to it in these cases have not been warranted by experience.

Notwithstanding the mildness and inactivity of crude quicksilver undivided; when resolved by fire into the form of fume, or otherwise divided into very minute particles, and prevented from re-uniting by the interposition of proper substances, or combined with mineral acids, it has very powerful effects; affording the most violent poisons, and the most excellent remedies, that we are acquainted with.

The mercurial preparations, either given internally or introduced into the habit by external application, seem to liquify all the juices of the body, even those in the minutest and most remote vessels; and may be so managed as to promote excretion through all the emunctories. Hence their common use in inveterate chronic disorders proceeding from a thickness and sluggishness of the humours, and obstinate obstructions of the excretory glands; in scrophulous and cutaneous diseases; and in the venereal lues. If their power is not restrained by proper additions to certain emunctories, they tend chiefly to affect the mouth; and, after having fused the juices in the remoter parts, occasion a plentiful evacuation of them from the salival glands.

The salutary effects of mercurials do not depend on the quantity of sensible evacuation. This medicine may be gradually introduced into the habit, so as, without occasioning any remarkable discharge, to be productive of very happy effects. To answer this purpose, it should be given in very small doses, in conjunction with such substances as determine its action to the kidneys or the pores of the skin. By this method inveterate cutaneous and venereal distempers have been cured, without any other sensible excretion than a gentle increase of perspiration or urine. Where there are ulcers in any part, they discharge for some time a very fetid matter, the quantity of which becomes gradually less,

lefs, and at length the ulcer kindly heals. If the mercury fhould at any time, from cold or the like, affect the mouth, it may be reftrained by omitting a dofe, and, by warmth or fuitable medicines, promoting the perfpiration.

MERCURY, in the heathen mythology. See HERMES.

Moft of the actions and inventions of the Egyptian Mercury have likewife been afcribed to the Grecian, who was faid to be the fon of Jupiter and Maia, the daughter of Atlas. No one of all the heathen divinities had fo many functions allotted to him as this god: he had conftant employment both day and night, having been the common minifter and meffenger of the whole Pantheon; particularly of his father Jupiter, whom he ferved with indefatigable labour, and fometimes indeed in a capacity of no very honourable kind. Lucian is very pleafant upon the multitude of his avocations; and, according to the confeffion of the emperor Julian, Mercury was no hero, but rather one who infpired mankind with wit, learning, and the ornamental arts of life, than with courage. The pious emperor, however, omits fome of his attributes; for this god was not only the patron of trade, but alfo of theft and fraud.

Amphion is faid, by Paufanias, to have been the firft that erected an altar to this god; who, in return, invefted him with fuch extraordinary powers of mufic (and mafonry), as to enable him to fortify the city of Thebes in Bœotia, by the mere found of his lyre.

Horace gives us the beft part of his character.

Thou god of wit, from Atlas fprung,
Who by perfuafive power of tongue,
And graceful exercife, refin'd
The favage race of human kind,
Hail! winged meffenger of Jove,
And all th' immortal pow'rs above.
Sweet parent of the bending lyre,
Thy praife fhall all its founds infpire.
Artful and cunning to conceal
Whate'er in fportive theft you fteal,
When from the god who gilds the pole,
E'en yet a boy, his herds you ftole;
With angry voice the threat'ning pow'r
Bad thee thy fraudful prey reftore;
But of his quiver too beguil'd,
Pleas'd with the theft, Apollo fmil'd.
You were the wealthy Priam's guide,
When fafe from Agamemnon's pride,
Through hoftile camps, which round him fpread
Their watchful fires, his way he fped.
Unfpotted fpirits you confign
To bliſsful feats and joys divine;
And, pow'rful, with thy golden wand,
The light, unbodied crowd command:
Thus grateful does thy office prove
To gods below, and gods above. *Francis.*

This ode contains the fubftance of a very long hymn to Mercury, attributed to Homer. Almoft all the ancient poets relate the manner in which the Grecian Mercury difcovered the lyre; and tell us that it was an inftrument with feven ftrings; a circumftance which makes it effentially different from that faid to have been invented by the Egyptian Mercury, which had but three. However, there have been many claimants befides Mercury to the feven-ftringed lyre. See LYRE.

His moft magnificent temple was on mount Cylene, in Arcadia. He is defcribed by the poets as a fair beardlefs youth, with flaxen hair, lively blue eyes, and a fmiling countenance. He has wings fixed to his cap and fandals, and holds the caduceus (or ftaff furrounded with ferpents with two wings on the top) in his hand; and is frequently reprefented with a purfe, to fhow that he was the god of gain. The animals facred to him, were the dog, the goat, and the cock. In all the facrifices offered to him, the tongues of the victims were burnt; and thofe who efcaped imminent danger, facrificed to him a calf with milk and honey.

MERCURY, ☿ in aftronomy. See ASTRONOMY, n° 4, 20, 44, 108, 112.

MERCURY, in heraldry, a term ufed in blazoning by planets, for the purple colour ufed in the arms of fovereign princes.

MERCY-SEAT, in Jewifh antiquity. See PROPITIATORY.

MERGANSER. See MERGUS.

MERGUS, in ornithology, a genus of birds of the order of anferes; diftinguifhed by having the beak of a cylindrical figure, and hooked at the extremities, and its denticulations of a fubulated form. There are fix fpecies.

1. The cucullatus, or crefted diver of Catefby, has a globular creft, white on each fide; and the body is brown above, and white below. It is a native of America. See Plate CLXXVI. fig. 4.

2. The merganfer, or goofander, is a native of Europe. Thefe birds frequent our rivers and other frefh waters, efpecially in hard winters; they are great divers, and live on fifh. They are never feen in the fouthern parts of Great Britain during fummer; when they retire far north to breed; for in that feafon they have been fhot in the Hebrides. They are uncommonly rank, and fcarce eatable. The male weighs four pounds: its length is two feet four inches; the breadth three feet two. The bill is three inches long, narrow, and finely toothed or ferrated; the colour of that and of the irides is red. The *dun diver*, or female, is lefs than the male: the head and upper part of the neck is ferruginous; the throat white: the feathers on the hind part are long, and form a pendent creft: the back, the coverts of the wings, and the tail, are of a deep afh-colour: the greater quill-feathers are black, the leffer white; the breaft and middle of the belly are white, tinged with yellow.

3. The ferrator, or redbreafted merganfer, weighs about two pounds: the length is one foot nine inches, the breadth two feet feven; the bill is three inches long; the lower mandible red; the upper dufky; the irides a purplifh red: head and throat a fine changeable black and green: on the former a long pendent creft of the fame colour; the tail fhort and brown; the legs orange-coloured. The head and upper part of the female are of a deep rufh-colour, and the tail afh-coloured. Thefe birds breed in the northern parts of Great Britain.

4. The cafter has a crefted afh-coloured head, a white throat, and a black bill and legs. It inhabits the fouth of Europe.

5. The albellus, or fmew, weighs about 34 ounces: the length 18 inches, the breadth 26; the bill is near two inches long, and of a lead colour; the head is adorned with a long creft, white above, and black beneath: the head, neck, and whole under part of the body, are of a pure white; the tail is of a deep afh-colour, the legs a bluifh grey. The female, or *lough-diver*,

diver, is lefs then the male: the back, the fcapulars, and the tail are dufky; as, alfo the tail: the belly white.

6. The minutus, or redheaded fmew, weighs about 15 ounces; the length one foot four inches, the breadth one foot eleven: the bill is of a lead colour; the head flightly crefted, and of a ruft colour: the hind part of the neck is of a deep grey, the forepart clouded with a lighter colour of the fame kind: the back and tail are of a dufky afh-colour, the legs of a pale afh-colour.—It is a native of Europe.

MERIDIAN, in geography, a great circle fuppofed to be drawn through any part on the furface of the earth, and the two poles; and to which the fun is always perpendicular at noon.—In aftronomy, the circle is fuppofed to be in the heavens, and exactly perpendicular to the terreftrial one.

MERIONETHSIRE, a county of North-Wales, on the fouth has the county of Cardigan, on the north thofe of Carnarvon and Denbigh, on the eaft thofe of Montgomery and Denbigh, and on the weft the Irifh fea. Its length is about 35 miles, its breadth 25, and its circumference 108; containing between 4 and 50,000 acres, 637 parifhes, 3 towns, 26 rivers, and about 17000 inhabitants. The air of this county, which is more encumbered with mountains than any other in Wales, is exceeding fharp and bleak; and would be very unwholefome, if the vapours from the Irifh fea were not in a great meafure difperfed by the high winds to which this county is fubject. The foil is very rocky and barren; except in the valleys, which yield good corn, and pafture for cattle and fheep. As the country is fo mountainous, the inhabitants apply themfelves chiefly to grazing, keeping vaft flocks of fheep, deer, and goats, in the mountains, and living much upon butter, cheefe, fowl, and fifh, efpecially herrings. They have but little corn, and their black cattle are generally fold to the Englifh. The chief rivers of the county are the Dyffi or Tovy, the Avon, the Drwrydh, and the Dee, which laft runs through the lake called *Lhyn Tigid* or *Pimble Meer*, without mixing its waters with thofe of the lake, as is fuppofed: for the falmon, with which the river abounds, are never taken out of the main ftream; and the givineads, a fifh peculiar to the lake, are never found in it. This lake is very large; and winds, it is pretended, will make it overflow, but land-floods never. The fifh in the lakes, and the herbs on the rocks and mountains here, like thofe in Caernarvonfhire and other hilly parts of Wales, are faid to be much the fame as thofe of the Alps. This county lies in the diocefe of Bangor: it fends no member to parliament, except a knight of the fhire; for it has no towns of any note.—Dr Campbell is of opinion that this county is capable of much improvement, if the inhabitants underftood their own intereft and were induftrious.

MERIT, fignifies defert. This term is more particularly applied to fignify the moral goodnefs of the actions of men, and the rewards to which thofe actions intitle them.

MERLIN (Ambrofe), a famous Englifh poet, and reputed prophet, flourifhed at the end of the 5th century. Many furprifing and ridiculous thing are related of him. Several Englifh authors have reprefented him as the fon of an incubus, and as tranfporting from Ireland to England the great ftones which form Stonehenge on Salifbury plain. Extravagant prophecies and other works are alfo attributed to him, on which fome authors have written commentaries.

MERLIN, in ornithology. See FALCO.

MERLON, in fortification, is that part of a parapet which is terminated by two embrafures of a battery.

MERMAID, or MERMAN, a fea-creature frequently talked of, fuppofed half human and half a fifh.

However naturalifts may doubt of the reality of *mermen* or *mermaids*, we have teftimony enough to eftablifh it; though, how far thefe teftimonies may be authentic, we cannot take upon us to fay. In the year 1187, as Laray informs us, fuch a monfter was fifhed up in the county of Suffolk, and kept by the governor for fix months. It bore fo near a conformity with man, that nothing feemed wanting to it but fpeech. One day it took the opportunity of making its efcape; and, plunging into the fea, was never more heard of. *Hift. de Angleterre*, P. I. p. 403.

In the year 1430, after a huge tempeft, which broke down the dikes in Holland, and made way for the fea into the meadows, &c. fome girls of the town of Edam in Weft-Freezeland, going in a boat to milk their cows, perceived a mermaid embaraffed in the mud, with a very little water. They took it into their boat, and brought it with them to Edam, dreffed it in womens apparel, and taught it to fpin. It fed like one of them, but could never be brought to offer at fpeech. Some time afterwards it was brought to Haerlem, where it lived for fome years, though ftill fhowing an inclination to the water. Parival relates that they had given it fome notion of a Deity, and that it made its reverences very devoutly whenever it paffed by a crucifix. *Delices de Hollande*.

In the year 1560, near the ifland of Manar, on the weftern coaft of the ifland of Ceylon, fome fifhermen brought up, at one draught of a net, feven mer men and maids; of which, feveral Jefuits, and among the reft F. Hen. Henriques, and Dimas Bofquez phyficians to the viceroy of Goa, were witneffes. The phyfician, who examined them with a great deal of care, and made diffection thereof, afferts, that all the parts both internal and external were found perfectly conformable to thofe of men. See the *Hift. de la compagnie de Jefus*, P. II. T. IV. n° 276. where the relation is given at length.

We have another account of a merman, near the great rock called *Diamond*, on the coaft of Martinico. The perfons who faw it, gave in a precife defcription of it before a notary. They affirmed that they faw it wipe its hand over its face, and even heard it blow its nofe.

Another creature of the fame fpecies was caught in the Baltic in the year 1531, and fent as a prefent to Sigifmond king of Poland, with whom it lived three days, and was feen by all the court. Another very young one was taken near Rocca de Sintra, as related by Damian Goes.

The king of Portugal and the grand mafter of the order of St James, are faid to have had a fuit at law to determine which party thefe monfters belong to.

In Pontopidan's Natural Hiftory of Norway, alfo, we

we have accounts of mermaids; but not more remarkable or any way better attested than the above.

MERNS, or KINCARDINSHIRE, a county of Scotland, stretching 27 miles in length, and 20 in breadth, is bounded on the east by the German ocean, on the south by the river of North Esk, on the west by Angus, and on the north by the river Dee and Aberdeenshire. The country is pretty plain and level, fruitful in corn and pasturage, producing an infinite number of fir-trees, besides a great number of agreeable plantations; and along the sea-coasts there are many convenient creeks and harbours.—The people are Lowlanders, civil, hospitable, and industrious.—The name *Merns* is by some derived from that of a valiant nobleman, who, subduing the country, received it in reward from Kenneth II. Cambden supposes it to retain part of the ancient name of *Vernicones*. The other name is derived from *Kincardin*, its ancient capital, now an inconsiderable village. The stocking-trade employs the natives from the banks of the Dee to Stone-hive; from thence to the Northesk they are wholly employed in weaving.

MEROE, (anc. geog.), an island of Ethiopia beyond Egypt, in the Nile; with a cognominal town, the metropolis of the Ethiopians. Here the shadow is said to decrease twice a-year, viz. when the sun is in the 18th degree of Taurus and in the 14th of Leo, (Pliny). Josephus says, that its ancient name was *Saba*; but changed to *Meroe* by Cambyses, either after his sister or after his consort, who died there, (Strabo). All the ancients represent *Meroe* as an island, but in modern times it is a peninsula; to which greater credit is to be given, as more accurate than the ancient accounts.

MEROPS, in ornithology, a genus belonging to the order of picæ. The bill is crooked, flat, and carinated; the tongue is jagged at the point; and the feet are of the walking kind. There are six species, viz. 1. The apiaster, or bee-eater, has an iron-coloured back; the belly and tail are of a bluish green; and the throat is yellow. It inhabits the south of Europe. 2. The viridis, or Indian bee-eater, is green, with a black belt on the breast; and the throat and tail are black. 3. The congener is yellowish, with a green rump. It inhabits the south of Europe. 4. The superciliosus is green, with a white line both above and below the eyes, and a yellow throat. It is found in Madagascar. 5. The cinereus is variegated with red and yellow, with the two longest quill-feathers of the tail red. It is a native of America. 6. The cafer is grey, with a very long tail. It is a native of Ethiopia.

MERSE, a county of Scotland, called also *Berwickshire*. This last name it derives from the town of Berwick, which was the head of the shire before it fell into the hands of the English, and obtained the appellation of *Mers* or *March*, because it was one of the borders towards England. It is washed on the south and east by the river Tweed and the German Ocean, bounded on the west by Tweedale, and on the north by Lothian. It extends 24 miles from east to west, and the breadth amounts to 16. The face of the country is rough and irregular, exhibiting hills, moors, and mosses, with intermediate valleys, which are pleasant and fruitful. It is watered by many streams; and particularly by the famous Tweed, which, rising from the same hills that gave birth to the Clyde and Annan, runs with a rapid course thro' Tweedale Forest and Teviotdale, and after a course of 50 miles disembogues itself into the German Ocean. Notwithstanding the length of its course, it is not navigable above Berwick, where there is a noble bridge over it, consisting of 15 arches: there was another at Melross, where nothing but the piers now remain. A third, of five arches, is maintained at Peebles; and a fourth has some time ago been built at Kelso. The shire of Berwick is generally distinguished into the three divisions of Mers, Lammermuir, and Lauderdale. The Mers is low, pleasant, and tolerably fruitful in corn. Lammermuir is a hilly country, abounding with game, and yielding good pasture for sheep and black cattle. Lauderdale is a tract of land lying on each side of the river Lauder, agreeably varied with hill, dale, and forest, producing good store of corn and pasturage, and giving the title of earl to the family of Maitland: but the most fruitful and populous parts of Berwickshire, are those that lie along the Tweed, and on both sides of the lesser rivers White Water, Black Water, and Eye. The seats of noblemen and gentlemen abound in this county. Berwick was the chief town until it fell into the hands of the English, and was annexed to their monarchy in the reign of King Edward IV. At present the principal town is Duns.

MERSENNE (Marin), in Latin *Mersennus*, a learned French author, born at Oysé, in the province of Maine, anno 588. He studied at La Flêche at the same time with Des Cartes; with whom he contracted a strict friendship, which lasted till death. He afterwards went to Paris, and studied at the Sorbonne, and in 1611 entered himself among the Minims. He became well skilled in Hebrew, philosophy, and Mathematics. He was of a tranquil, sincere, and engaging temper; and was universally esteemed by persons illustrious for their birth, their dignity, and their learning. He taught philosophy and divinity in the convent of Nevers, and at length became superior of that convent; but being willing to apply himself to study with more freedom, he resigned all the posts he enjoyed in his order, and travelled into Germany, Italy, and the Netherlands. He wrote a great number of excellent works; the principal of which are, 1. *Quæstiones celeberrimæ in Genesim*. 2. *Harmonicorum libri*. 3. *De sonorum natura, causis, & effectibus*. 4. *Cogitata physico-mathematica*. 5. *La verité des Sciences*. 6. *Les questions innouies*. He died at Paris in 1648. He had the reputation of being one of the best men of his age. No person was more curious in penetrating into the secrets of nature, and carrying all the arts and sciences to their utmost perfection. He was in a manner the centre of all the men of learning, by the mutual correspondence which he managed between them. He omitted no means to engage them to publish their works; and the world is obliged to him for several excellent discoveries, which, had it not been for him, would perhaps have been lost.

MERULA (George), an Italian of extraordinary parts and learning, born at Alexandria in the duchy of Milan about the year 1420. He taught youth at Venice and Milan for 40 years, and laboured abundantly

ly in restoring and correcting ancient authors. He wrote, and addressed to Lewis Sforza, *Antiquitates Vicecomitum;* or "The actions of the Dukes of Milan," in 10 books; with some other things in the same way. His death, in 1494, is said not to have grieved any body; as he lived in a state of war with, and abused, almost all his cotemporary scholars.

MERULA (Paul), born at Dort in Holland, a famous lawyer, historian, and linguist, was professor of history in the university of Leyden after Lipsius. He wrote, 1. Commentaries on Ennius. 2. The life of Erasmus and Junius. 3. A cosmography. 4. A treatise of law; and died in 1607.

MERUS, (anc. geog.), a mountain of the Hither India, hanging over the city Nyssa, built by Bacchus, and situated between the rivers Cophen and Indus. The name, denoting the *thigh*, gave rise to the fable of Bacchus being inserted into Jupiter's thigh, and being born twice; because in this mountain he and his army are said to have been preserved, when disease and pestilence raged in the plains below.

MERA-DE-ASTA, formerly a large town of Andalusia, seated on the river Guadaleta, between Arcos and Xeres de la Frontera; but now only a large heap of ruins. Here the Arabs conquered Roderick the last king of the Goths, and by that victory became masters of Spain in 713.

MESCHED, a considerable town of Persia, and in the province of Khorassan; fortified with several towers, and famous for the magnificent sepulchre of Iman Risa, of the family of Ali, to whom the Persians pay great devotion. It is seated on a mountain near this town, in which are fine turquoise-stones; in E. Long. 59. 25. N. Lat. 37. 0.

MESEMBRYANTHEMUM, FIG-MARIGOLD; a genus of the pentagynia order, belonging to the pentandria class of plants. There are between 40 and 50 species; all African plants, from the Cape of Good Hope; near 40 of which are retained in our gardens for variety. Of these only one is annual, and the most remarkable of them all. It is called the *crystallium, diamond ficoides*, or *ice-plant*. It rises with a short, thick, succulent stalk, dividing low into many trailing, very spreading, succulent branches, bespangled all over with icy pimples; very pellucid and glittering; oval, undulate, alternate, papulose or pimply, glittering leaves; and from the sides of the branches, numerous, almost close fitting, white flowers, tinged with red or crimson; succeeded by plenty of seed in autumn. This singular and curious plant, being closely covered with large pellucid pimples, full of moisture shining brilliantly like diamonds, is in great esteem. It is a very tender plant while young; and is raised annually from seed by means of hot-beds. In June it will endure the open air till October, when it perishes; but if placed in a hot-house in autumn, it will often live all winter. It is commonly planted in pots for the conveniency of removing from place to place; but if planted in the full ground, it grows considerably stronger, even to luxuriance: however, when confined in pots, it flowers more abundantly.

The other species are mostly durable in stem and foliage. Some are shrubby; others pendulous, with loose straggling stems, and branches inclining to the ground; while others have no stalks at all: their leaves are universally very thick, succulent, fleshy; and of many various shapes, situations, and directions; while some are curiously punctured, or dotted with transparent points, and some have pellucid pimples, as already mentioned: they afford a very agreeable variety, at all times in the year, and merit a place in every collection. They are green-house plants, and are propagated by cuttings of their stalks and branches.

MESENTERY, in anatomy. See there, n° 355.

MESENTERITIS, or *Inflammation of the* MESENTERY. See MEDICINE, n° 296.

MESOCOLON, in anatomy. See there, n° 355, c.

MESOLOGARITHMS, according to Kepler, are the logarithms of the co-sines and co-tangents; the former of which were called by Lord Napier *anti-logarithms*, and the latter *differentials*.

MESOPOTAMIA, the ancient name of the province of DIARBECK, in Turkey in Asia. It is situated between the rivers Euphrates and Tigris; having Assyria on the east, Armenia on the north, Syria on the west, and Arabia Deserta with Babylonia on the south. In Scripture it is called *Padan Aram*.

MESOPTERYGIUS, in ichthyology, a term applied to such fishes as have only one back-fin; and that situated in the middle of the back.

MESPILUS, the MEDLAR; a genus of the pentagynia order, belonging to the icosandria class of plants. There are seven species, *viz.*

1. The Germanica, German mespilus, or common medlar, rises with a deformed tree-stem, branching irregularly 15 or 20 feet high; spear-shaped leaves, downy underneath; and large close-fitting, white flowers, singly from the sides of the branches; succeeded by large roundish brown fruit, the size of middling apples, which ripen in October, but are not eatable till beginning to decay. The varieties are, common great German medlar—smaller Nottingham medlar—pear-shaped Italian medlar. This species and varieties are all cultivated in the English gardens for the fruit: but the German or Dutch medlar, and the Nottingham kind, are the most common; and the latter of which two, though a smaller fruit, is rather preferable for richness and poignancy of flavour. These kinds of fruit are never eatable until they begin to rot; for when firm and sound, they are of a singularly austere disagreeable taste; yet having lain some time after being gathered, till they begin to assume a state of decay and become soft, they acquire a delicious flavour, extremely agreeable to many, though to others altogether unpalatable.

All the sorts ripen in the latter end of October, or beginning of November; when being gathered, some should be laid in moist bran, in several layers, to forward their decay; others on straw in the fruitery: those in the bran will begin to be ready for use in about a fortnight, and those laid on straw will come gradually forward in succession.

2. The arbutifolia, arbutus-leaved mespilus, hath a shrubby stem, branching erectly five or six feet high; lanceolate, crenated, alternate leaves, downy underneath; and from the sides and ends of the branches, small white flowers in clusters; succeeded by small, roundish, purple fruit, like haws.

3. The amelanchier, or shrubby medlar, with black fruit, rises with several shrubby, slender, hairy stems, branching

branching moderately about four feet high, having purplifh branches; oval, ferrated leaves, downy underneath; and fmall white flowers, in clufters at the ends of the branches; fucceeded by fmall black fruit.

4. The chamæ-mefpilus, or dwarf medlar, commonly called *baftard quince*, hath a fhrubby, flender, fmooth ftem, branching weakly four or five feet high, having purplifh branches; oval, ferrated, fmooth leaves, on long foot-ftalks; and from the axillas, purple flowers, collected into round heads, with narrow, purplifh, deciduous bracteæ; fucceeded by fmall red fruit.

5. The cotoneafter, commonly called *dwarf quince*, rifes with a fhrubby, fmooth ftem, branching four or five feet high, the branches flender and reddifh; oval entire leaves on fhort foot-ftalks; and from the axillas, fmall clofe-fitting purple flowers, two or three together; fucceeded by fmall, roundifh, bright-red fruit.

6. The Canadenfis, Canada fnowy mefpilus, hath a fhrubby, fmooth ftem, branching four or five feet high, with fmooth, purplifh branches; oval-oblong, ferrated, fmooth leaves, on long footftalks; and all the branches terminated by clufters of fnowy-white flowers; fucceeded by fmall, purplifh fruit, like haws.

3. The pyracantha, or ever-green thorn, rifes with a fhrubby, fpinous ftem, branching diffufely 12 or 14 feet high, the branches flender and flexible, with a dark-greenifh bark, armed with long fharp fpines; fpear-fhaped-oval, crenated, ever-green leaves; and all the fhoots terminated by numerous clufters of whitifh flowers; fucceeded by large bunches of beautiful red berries, remaining all winter, and exhibiting a very ornamental appearance.

All thefe feven fpecies of mefpilus are of the tree and fhrub kind; the firft fix forts are deciduous, the feventh an ever-green: the leaves are univerfally fimple; thofe of the mefpilus Germanica very large, the others moftly of moderate fize, and which in moft of the forts grow upon fhort foot-ftalks. They all flower abundantly every fummer, the flowers univerfally hermaphrodite, and confifting each of five large roundifh petals, 20 ftamina, and five ftyles. They are all very hardy, and fucceed in any common foil and fituation, and their propagation and culture is very eafy.

The firft fort and varieties are cultivated as fruit-trees, principally as ftandards, fometimes alfo as efpaliers for variety. The other fpecies are very proper furniture for any ornamental plantation, where they will make an agreeable variety with their different foliage; and their flowers make a fine appearance, as alfo their fruit in autumn and winter, which, if not devoured by birds, remain long on the branches, and afford a fine variety in thofe feafons. The pyracantha, being rather of flexible growth, is moft commonly trained againft walls or the fronts of houfes, both for the fupport of its flexible branches, and that it may exhibit its berries more ornamentally.

When it is defigned to have any of the common medlars as fruit-trees, they may be trained either as dwarfs, for dwarf ftandards, or for efpaliers, or trained as half or full ftandards; and managed in either of thofe modes of training nearly as other fruit-trees, particularly the apple and pear; and are raifed either by feed, by grafting, or by budding, but either of the two latter methods are the moft certain for continuing the forts without variation: obferving, after fhortening their firft fhoots from the graft or bud, where it fhall feem neceffary to force out a proper fupply of wood to form a head, to train the branches afterwards principally at full length, and let the ftandards branch out in their own way.

MESS, in a military fenfe, implies a number of foldiers, who, by laying away a certain proportion of their pay towards provifions, mefs together: fix or eight is generally the number of each mefs. Experience proves, that nothing contributes more to the health of a foldier, than a regular and well-chofen diet, and his being obliged every day to boil the pot: it corrects drunkennefs, and in a great meafure prevents gaming, and thereby defertion.

MESSANA, (anc. geog.), the firft town of Sicily on croffing over from Italy, fituate on the ftrait now called the *Faro*, (Italicus). Anciently called *Zancle*, according to Diodorus Siculus, from king Zanclus; or, according to others, from the Sicilian term *Zanclon*, denoting a fickle, alluding to the curvity of the coaft: a name appropriated by the poets; and hence *Zanclæi*, the people, (Herodotus, Paufanias). The other name *Meffana* is from the *Meffenii* of Peloponnefus, (Strabo). Thucydides afcribes its origin to Anaxilas the Meffenian, tyrant of Rhegium, who received all comers, calling the town after the name of his country. The Greeks always call it *Meffene;* the Romans *Meffana* conftantly, to diftinguifh it from *Meffene* of Peloponnefus. Now MESSINA.

MESSENA, or MESSENE, an inland town, and the capital of Meffenia, a country of Peloponnefus; erroneoufly placed by Ptolemy on the coaft. It was built by Epaminondas, who recalled all the Meffenian exiles, and gave the town the name of *Meffene*. A place vying in point of ftrength and fituation with Corinth, according to Strabo; and therefore Demetrius Pharius advifed Philip, father of Perfeus, that if he wanted to have Peloponnefus in his power, he fhould make himfelf mafter of thefe two towns, as thus he would have the ox by both horns.

MESSENIA, a country in the fouth of Peloponnefus, moftly maritime, fituate between Elea to the weft, and Laconica to the eaft. Anciently a part of Laconica under Menelaus, and called *Meffene* by Homer; interpreted by the fcholiaft, *Meffenæa Regia*. *Meffenii*, the people, reduced to a ftate of flavery and fubjection by the Spartans; *Meffenius*, the epithet.

This country is famous in hiftory, on account of the refiftance made by the Meffenians againft the Spartans, and the exploits of their hero Ariftomenes. The firft hoftilities commenced about the year 652 B. C. on what occafion is uncertain. Though the Meffenians were inferior in the knowledge of the art of war to the Spartans; yet, by keeping for fome time on the defenfive, they improved fo much, that in three years time they found themfelves in a capacity of giving battle to their enemies in the open field; nor did they appear to be in any degree inferior either in courage or conduct: the war was therefore protracted, with various fuccefs, on both fides. At laft, both confulted the oracle at Delphi; and received for anfwer, "that whoever fhould firft dedicate 100 tripods in the temple of Jupiter at Ithome, a ftrong-hold of the Meffenians, fhould be mafters of the

Meſſenia. the country." The inhabitants of Meſſenia, on hearing this, having no money to make the tripods of braſs, fell to cutting them out in wood; but before this could be accompliſhed, a Spartan having got into the city by ſtratagem, dedicated 100 little tripods of clay: which threw the Meſſenians into ſuch deſpair, that they at laſt ſubmitted to the Spartans.

The new ſubjects of Sparta were treated with the utmoſt barbarity by theſe cruel tyrants; ſo that in 685 B.C. a new war commenced under Ariſtomenes, a man of unconquerable valour, and enthuſiaſtically fond of liberty. He perceived that the Argives and Arcadians, who were called the *allies* of the Lacedæmonians, adhered to them only through fear of their power; but that in reality they hated them, and wiſhed to revenge the injuries they had done them. To theſe Ariſtomenes applied; and receiving an anſwer conformable to his wiſhes, he engaged his countrymen unanimouſly to take up arms. About a year after the revolt began, and before either party had received any auxiliaries, the Spartans and Meſſenians met at a village called *Deræ*, where an obſtinate engagement enſued. Ariſtomenes was conceived to have performed more than mortal atchievements: in gratitude therefore, reſpect being alſo had to his royal deſcent, his countrymen unanimouſly ſaluted him *king;* which title he modeſtly waved, alleging, that he took up arms to ſet them free, and not to make himſelf great: he conſented, however, to accept the title of *general*, with a power of doing whatſoever he thought requiſite for the ſervice of the public. Knowing well the ſuperſtition of the age in which he lived, he reſolved to intimidate the Spartans, by ſhowing them what he was ſure they would take for an ill omen. Diſguiſing himſelf therefore, he went privately to the city, where, in the night, he hung up a ſhield on the wall of the temple of Minerva, with this inſcription: *Ariſtomenes dedicates this, out of the ſpoils of the Spartans, to the goddeſs.* It was eaſily perceived that this war would be both long and bloody; the Lacedæmonians therefore ſent deputies to Delphi, to inquire of the oracle concerning its event: the anſwer they received was, *That it behoved the Spartans to ſeek a leader from Athens.* The Athenians, naturally envious of the Spartans, granted their requeſt indeed, but in ſuch a manner as manifeſted their ſpite; for they ſent them for a general Tyrtæus, a ſchoolmaſter and poet, lame of one foot, and who was ſuſpected to be a little out of his wits. But here their ſkill failed them; for this captain, notwithſtanding his deſpicable appearance, proved of great conſequence to Sparta, teaching them how to uſe good, and how to bear up under evil fortune.

In the mean time, Ariſtomenes had drawn together a mighty army, the Eleans, Argives, Sicyonians, and Arcadians, having ſent troops to his aſſiſtance; the Spartans in this, as in the former war, having no ally but Corinth. The Spartan kings, according to the cuſtom of their city, no ſooner took the field, than, notwithſtanding their inferiority in number, they offered the enemy battle, which Ariſtomenes readily accepted.—It was long, obſtinate, and bloody; but in the end the Meſſenians were victorious, and the Lacedæmonians put to flight, with a great ſlaughter. It is ſcarce to be conceived how much the Spartans were ſtruck with this defeat: they grew weary of the war, diſſatisfied with their kings, diffident of their own power, and, in a word, ſunk into a ſtate of general uneaſineſs and want of ſpirit. It was now that the Athenian general convinced them, that he was capable of fulfilling all the promiſes of the oracle; he encouraged them by his poems, directed them by his counſels, and recruited their broken armies with choſen men from among the Helotes. Ariſtomenes, on the other hand, acted with no leſs prudence and vigour. He thought it not enough to reſtore the reputation of the Meſſenians, if he did not alſo reſtore their wealth and power: he therefore taught them to act offenſively againſt their enemies; and, entering the territories of Sparta, he took and plundered Pharæ, a conſiderable borough in Laconia, putting all ſuch as made any reſiſtance to the ſword, carrying off at the ſame time an immenſe booty. This, however, was an injury which the Spartans could not brook with patience; they therefore ſent immediately a body of forces to overtake the Meſſenians, which accordingly they did: but Ariſtomenes routed theſe purſuers, and continued to make a mighty ſlaughter of them, till ſuch time as he was diſabled by having a ſpear thruſt in his ſide, which occaſioned his being carried out of the battle. His cure, which took up ſome time, being finiſhed, he reſolved to carry the war even to the gates of Sparta; and to that purpoſe raiſed a very great army: but, whether he found his deſign impracticable, or was really diverted by ſome dream, he gave out, that Caſtor and Pollux, with their ſiſter Helena, had appeared to him, and commanded him to deſiſt. A ſhort time after this retreat, going with a ſmall party to make an incurſion, and attempting to take priſoners ſome women who were celebrating religious rites near Egila, a village in Laconia, thoſe zealous matrons fell upon him and his ſoldiers with ſuch fury, that they put them to flight, and took him priſoner: however, he ſoon afterwards made his eſcape, and rejoined his forces. In the third year of the war, the Spartans, with a great force, entered Meſſenia, whither Ariſtocrates king of Arcadia was come, with a great body of troops, to the aſſiſtance of his allies: Ariſtomenes therefore made no difficulty of fighting when the Spartans approached; but they entering privately into a negociation with Ariſtocrates, engaged him with bribes and promiſes to betray his confederates. When the battle began, the deceitful Arcadian repreſented to the forces under his command, the mighty danger they were in, and the great difficulty there would be of retreating into their own country, in caſe the battle ſhould be loſt: he then pretended, that the ſacrifices were ominous; and, having terrified his Arcadians into the diſpoſition of mind fitteſt to ſerve his purpoſe, he not only drew them off from both wings, but, in his flight, forced through the Meſſenian ranks, and put them too in confuſion. Ariſtomenes and his troops, however, drew themſelves into cloſe order, that they might defend themſelves the beſt they could: and indeed they had need of all their valour and ſkill; for the Lacedæmonians, who expected this event, immediately attacked and ſurrounded them on all ſides. Fortune was, on this occaſion, too powerful either for the courage or the conduct of the Meſſenians; ſo that, notwithſtand-

ing their utmoft efforts, moft of their army were cut to pieces, and, amongft them, the chief of their nobility. Ariftomenes, with the poor remains of his fhattered forres, retired as well as he could; and, perceiving that it was now impoffible to maintain the war againft the Lacedæmonians upon equal terms, he exhorted his countrymen to fortify mount Era, and to make the beft difpofitions poffible for a long defence. He likewife placed garrifons in Pylus and Methone on the fea-coafts; and to thefe three places he gathered all the inhabitants, leaving the reft of Meffenia to the mercy of the Spartans. They, on the other hand, looked on the war as now in a manner finifhed; for which reafon they divided the lands among their citizens, and caufed them to be carefully cultivated, while they befieged Era. But Ariftomenes quickly convinced them that the war was far from being over: he chofe out of all the Meffenians 300 men, with whom he ravaged all the adjacent country; carried off a prodigious booty; and, when Meffenia could no longer fupply the wants of his garrifon, penetrated into Laconia, and bore away corn, wine, cattle, and whatever elfe was neceffary to the fubfiftence of his countrymen fhut up in Era: fo that at laft the Spartans were conftrained to iffue a proclamation, forbidding the cultivation, not only of the Meffenian territory in their hands, but alfo of Laconia in its vicinity; whereby they diftreffed themfelves more than their enemies, inducing at laft a famine in Sparta itfelf, which brought with it its ufual attendant, fedition. Here again all things had gone wrong, if the wifdom of the poet Tyrtæus had not fupported the Spartan courage; nor was it without much difficulty that he influenced them to continue the blockade of Era, and to maintain a flying camp for the fecurity of the country.

Ariftomenes, in fpite of all thefe precautions, committed terrible depredations with his fmall corps of 300 men. Amongft other places which he plundered, the city of Amyclæ was one; from whence he carried not only a great quantity of riches, but alfo many carriages laden with provifions. The kings of Sparta lying with their troops in its neighbourhood, as foon as they heard of this expedition, marched after Ariftomenes with the utmoft diligence; and, as the Meffenians were incumbered with their booty, came up with them before he could reach Era. In this fituation of things, Ariftomenes, prompted rather by defpair than prudence, difpofed his troops in order of battle; and, notwithftanding they were fo few, made a long and vigorous refiftance againft the whole Lacedæmonian army. At length, however, numbers prevailed: the greateft part of the Meffenians were flain on the fpot; and Ariftomenes, with about 50 of his men who furvived the flaughter, were taken prifoners; that chief having received fo many wounds, that he was fenfelefs when they carried him away. The Lacedæmonians expreffed the loudeft joy at the fight of this illuftrious captive; who, for fo many years, by his fingle abilities, had enabled his exhaufted country to defend itfelf againft the whole force of Sparta. When he was recovered of his wounds, they decreed him and all his fellow-prifoners to be thrown together into a deep cavern, which was the common punifhment of the loweft kind of offenders. This judgment was executed with the utmoft feverity, excepting that Ariftomenes had leave to put on his armour. Three days he continued in this difmal place, lying upon, and covered over with, dead bodies. The third day, he was almoft famifhed through want of food, and almoft poifoned with the ftench of corrupted carcafes, when he heard a fox gnawing a body near him. Upon this he uncovered his face, and perceiving the fox juft by him, he with one hand feized one of its hind-legs, and with the other defended his face, by catching hold of its jaw when it attempted to bite him. Following as well as he could his ftraggling guide, the fox at laft thruft his head into a little hole; and Ariftomenes then letting go his leg, he foon forced his way through, and opened a paffage to the welcome rays of light, from which the noble Meffenian had been fo long debarred. Feeble as he was, Ariftomenes wrought himfelf an outlet with his nails; and travelling by night with all the expedition he could, at length arrived fafe at Era, to the great joy and amazement of his countrymen. When this news was firft blazed abroad, the Spartans would have had it pafs for a fiction; but Ariftomenes foon put the truth of it out of doubt, by falling on the pofts of the Corinthians, who, as allies of the Spartans, had a confiderable body of troops before Era. Moft of their officers, with a multitude of private men, he flew; pillaged their camp; and, in fhort, did fo much mifchief, that the Spartans, under the pretence of an approaching feftival, agreed to a ceffation of arms for 40 days, that they might have time to bury their dead. On this occafion, Ariftomenes for the fecond time celebrated the *hecatomphonia*, or the facrifice appointed for thofe who had killed 100 of the enemy with their own hands. He had performed the fame before and after his fecond battle; and he lived to do it a third time: which muft appear wonderful to the reader, when he is informed, that, notwithftanding this truce, certain Cretan archers in the fervice of the Spartans, feized Ariftomenes as he was walking without the walls, and carried him away a prifoner. There were nine of them in all; two of them immediately flew with the news to Sparta, and feven remained to guard their prize, whom they bound, and conducted to a lone cottage inhabited only by a widow and her daughter. It fo fell out, that the young woman dreamt the night before, that fhe faw a lion without claws, bound, and dragged along by wolves; and that fhe having loofed his bonds, and given him claws, he immediately tore the wolves to pieces. As foon as Ariftomenes came into the cottage, and her mother, who knew him, had told her who he was, fhe inftantly concluded that her dream was fulfilled; and therefore plied the Cretans with drink, and, when they were afleep, took a poniard from one of them, cut the thongs with which Ariftomenes was bound, and then put it into his hands. He prefently verified her vifion, by putting all his guards to death; and then carried her and her mother to Era, where, as a reward for her fervice, he married the young woman to his fon Gorgus, then about 18 years of age.

When Era had held out near eleven years, it fell into the hands of Sparta by an accident: the fervant of one Empiramus, a Spartan commander, driving his mafter's cattle to drink at the river Neda, met frequently with the wife of a Meffenian, whom he engaged

engaged in an amour. This woman gave him notice, that her hufband's houfe was without the wall; fo that he could come to it without danger, when the good man was abroad; and fhe likewife gave him intelligence when her hufband was upon duty in the garrifon. The Spartan failed not to come at the time appointed; but they had not been long in bed before the hufhand returned, which put the houfe into great confufion: the woman, however, fecured her gallant; and then let in her hufband, whom fhe received, in appearance, with great joy, inquiring again and again by what excefs of good fortune fhe was bleffed with his return. The innocent Meffenian told her, that Ariftomenes being detained in his bed by a wound, the foldiers, knowing that he could not walk the rounds, had a grant to retire to their houfes, to avoid the inclemency of the feafon. The Spartan no fooner heard this, than he crept foftly out of doors, and haftened away to carry the news to his mafter. It fo happened, that the kings were at this time abfent from the camp, and Empiranus had the chief command of the army. As foon as he received this information, he ordered his army to begin its march, though it rained exceffively, and there was no moon-light. The fellow guided them to the ford, and managed matters fo well that they feized all the Meffenian pofts: yet, after all, they were afraid to engage; darknefs, an high wind, heavy rain, together with the dread of Ariftomenes, keeping them quiet in the places they had feized. As foon as it was light, the attack began; and Era had been quickly taken, if only the men had defended it; but the women fought with fuch fury, and, by their mingling in the fray, brought fuch an acceffion of numbers, as made the event doubtful. Three days and two nights this defperate engagement lafted: at laft, all hopes of preferving the city being loft, Ariftomenes drew off his wearied troops. Early the fourth morning, he difpofed the women and children in the centre, the Meffenian youth in the front and rear, the lefs able men in the main body: himfelf commanded the van; the rear-guard was brought up by Gorgus and Manticlus, the former the fon of Ariftomenes, the latter of Theocles, a Meffenian of great merit, who fell with much glory in this attack, fighting valiantly in the caufe of his country. When all things were ready, Ariftomenes caufed the laft barrier to be thrown open; and, brandifhing his fpear, marched directly towards the Spartan troops, in order to force a paffage. Empiramus, perceiving his intent, ordered his men to open to the right and left, and fairly gave them a paffage; fo that Ariftomenes marched off in triumph, as it were, to Arcadia.

The Arcadians, when they heard that Era was taken, were very defirous of fuccouring their old confederates in this deep diftrefs: they therefore intreated their king Ariftocrates to lead them into Meffenia. But he, corrupted by the Lacedæmonians, perfuaded them that it was too late; that the Meffenians were all cut off; and that fuch a ftep would only expofe them to the fury of the conquerors. When the thing appeared to be otherwife, and it was known that Ariftomenes was on the frontiers of Arcadia, they went in crowds to carry him provifions, and to teftify their readinefs to afford him and thofe under his command all the affiftance in their power. Ariftomenes defired to be heard before a general affembly; which being accordingly convoked, he there opened one of the boldeft and beft-laid fchemes recorded in hiftory: he faid, that he had yet 500 undaunted foldiers, who, at his command, would undertake any thing; that it was very probable moft of the Spartans were employed in pillaging Era, and that therefore he determined to march and furprife Sparta; which appeared fo fenfible, that all the affembly loudly commended his great capacity and unfhaken courage. Ariftocrates, however, took care to betray him; having, by various pretences, retarded the execution of the project. The Arcadians, who began to fufpect him, waited for and furprifed the meffengers as they came back. They took the letters from him, and read them openly in the affembly. The purport of them was, that they acknowleged his great kindnefs both now and in the battle; and promifed, that the Lacedæmonians would be grateful. As foon as the letters were read, the Arcadians fell to ftoning their king, frequently calling upon the Meffenians to affift them; which, however, they did not, waiting for Ariftomenes's orders; who, far from triumphing in this fpectacle, ftood ftill, with his eyes fixed on the ground, which he wet with his tears, his foul pierced with forrow to fee a crowned head fo fhamefully and fo defervedly put to death. The Arcadians afterwards exected a monument over him, with an infcription to perpetuate his infamy. As for the Meffenians under the command of Gorgus and Manticlus, they paffed over into Sicily; where they founded the city of Meffene, one of the moft famous in the ifland. Ariftomenes remained, however, in Greece; where he married all his daughters, except the youngeft, to perfons of great rank. A prince of Rhodes, inquiring of the oracle at Delphi whom he fhould efpoufe, that his fubjects might be happy under his pofterity, was directed to marry the daughter of the moft worthy of the Greeks; which aufwer was immediately underftood to point at the virgin daughter of Ariftomenes. Her therefore he demanded, and received; Ariftomenes accompanying him back to his dominions, where he formed a fcheme of uniting the Lydians and Medes againft the Spartans, refolving, with this view, to go into Media, and to the court of Sardis: but while he meditated thefe great things, death furprifed him, and thereby freed Lacedæmon from the moft formidable enemy fhe ever had.

MESSENGERS, are certain officers chiefly employed under the direction of the fecretaries of ftate, and always in readinefs to be fent with all kinds of difpatches foreign and domeftic. They alfo, by virtue of the fecretaries warrants, take up perfons for high treafon, or other offences againft the ftate. The prifoners they apprehend are ufually kept at their own houfes, for each of which they are allowed 6s. 8d. per day, by the government: and when they are fent abroad, they have a ftated allowance for their journey, viz. 30l. for going to Paris, Edinburgh, or Dublin; 25 l. for going to Holland, and to other places in the fame proportion; part of which money is advanced, for the expence of their journey. Their ftanding falary is 45 l. *per annum*; and their pofts, if purchafed, are efteemed worth 300l. The meffengers wait 20

at a time, monthly, and are distributed as follows, viz. four at court, five at one secretary's office, five at another, two at the third for North Britain, three at the council-office, and one at the lord chamberlain's of the household.

MESSENGERS, in Scotland. See LAW, n° clviii. 16.

MESSENGERS *of the Exchequer*, are four officers who attend the exchequer, in the nature of pursuivants, and carry the lord treasurer's letters, precepts, &c.

MESSENGER *of the Press*, a person who, by order of the court, searches printing-houses, booksellers shops, &c. in order to discover the printers or publishers of seditious books, pamphlets, &c.

MESSIAH, a word signifying one *anointed*, or installed into an office by unction. It was usual among the Jews to anoint kings, high-priests, and sometimes prophets, at the designation or installment of them, to signify emblematically the mental qualifications necessary for discharging these offices. Saul, David, Solomon, and Joash, kings of Judah, received the royal unction. Aaron and his sons received the sacerdotal, and Elisha the disciple of Elijah received the prophetic, unction.—The name MESSIAH, *Anointed*, or *Christ* (Χριστος), was given to the kings and high-priests of the Jews. The patriarchs and prophets are also called by the name of *Messiahs* or the *Lord's anointed*. See 1 Sam. xii. 3, 5. 1 Chron. xvi. 22. Ps. cv. 15.

But this name MESSIAH was principally and by way of eminence given by the Jews to their expected great Deliverer, whose coming they still vainly wait; and is a name the Christians apply to JESUS *Christ*, in whom the prophecies relating to the Messiah were accomplished. The sum of these prophecies is, That there should be a glorious person, named *Messiah*, descended from Abraham, Isaac, and Jacob, who should be born at Bethlehem, of a virgin of the family of David, then in its decline, before the Jews ceased to be a people, while the second temple was standing, and about 500 years after Ezra's time; who, though appearing in mean circumstances, should be introduced by a remarkable forerunner, whose business it should be to awaken the attention and expectation of the people. That this illustrious person called *Messiah*, should himself be eminent for the piety, wisdom, and benevolence of his character, and the miraculous works he should perform: yet that, notwithstanding all this, he should be rejected and put to death by the Jews; but should afterwards be raised from the dead, and exalted to a glorious throne, on which he should through all generations continue to rule, at the same time making intercession for sinners. That great calamities should for the present be brought on the Jews for rejecting him: whereas the kingdom of God should by his means be erected among the Gentiles, and disperse itself even unto the ends of the earth; wherever it came, destroying idolatry, and establishing true religion and righteousness. In a word, That this glorious Person should be regarded by all who believed in him, as a divine teacher, an atoning sacrifice, and a royal governor: by means of whom God would make a covenant with his people, very different from that made with Israel of old; in consequence of which they should be restored to, and established in, the divine favour, and fixed in a state of perpetual happiness. See JESUS *Christ*, and CHRISTIANITY.

MESSUAGE, MESSUAGIUM, in law, a dwelling-house, with some land adjoining assigned for its use. By the name of *messuage* may a garden, shop, mill, cottage, chamber, cellar, or the like, pass.—In Scotland, *messuage* denotes what is called in England the *manor-house*; viz. the principal dwelling-house within any barony.

METACARPUS, in anatomy. See there, n° 54.

METALEPSIS. See ORATORY, n° 59.

METALLIZATION, the natural process by which metals are formed in the bowels of the earth. See METALLURGY, sect. i.

METALS. See METALLURGY; and CHEMISTRY, n° 43, 140, 192, 236, 278, 332, 348.

METAL, in heraldry. There are two metals used in heraldry, by way of colours, viz. gold and silver, in blazon called *or* and *argent*.

In the common painting of arms these metals are represented by white and yellow, which are the natural colours of those metals. In engraving, gold is expressed by dotting the coat, &c. all over; and silver, by leaving it quite blank.

It is a general rule in heraldry, never to place metal upon metal, nor colour upon colour: so that if the field be of one of the metals, the bearing must be of some colour; and if the field be of any colour, the bearing must be of one of the metals.

METALLURGY.

METALLURGY, according to Boerhaave, comprehends the whole art of working metals, from the glebe or ore, to the utensil; in which sense, essaying, smelting, refining, parting, smithery, gilding, &c. are only branches of metallurgy. But, in the present work, Gilding, Parting, Purifying, Refining, Smithery, &c. are treated under their proper names. With others, therefore, we have chosen to restrain *Metallurgy* to those operations required to separate metals from their ores for the uses of life. These operations are of two kinds: the smaller, or Essaying; and the larger, or Smelting. But a particular description of the ores themselves seemed likewise necessary to be given; and to this place, too, we have referred a general account of metals, metallization, mines, and ores, as a proper introduction to the subject. Hence the following division into three parts. The *first* treating, 1. Of metals and metallization. 2. Of mines and ores in general. 3. Of the pyrites. 4. Of the essaying of ores in general. The *second*, Of the particular ores, and the methods of essaying them. The *third*, Of smelting of ores, or the methods of extracting metals from large quantities of ores for the purposes of commerce or manufacture.

PART I.

Sect. I. *Of Metals and Metallization.*

UNDER the general name *metal*, we comprehend here not only the metals properly fo called, but alfo the *femimetals*, or all matters which have the effential metallic properties, which we fhall here recount. Thus the word *metal* and *metallic fubftance* will be fynonimous in this article.

Metallic fubftances form a clafs of bodies, not very numerous, of very great importance in chemiftry, medicine, arts, and the ordinary affairs of life. Thefe fubftances have very peculiar properties, by which they differ from all other bodies.

The natural bodies from which metals differ the leaft are, earthy and pyritous matters, on account of their folidity and denfity. Metals and ftones are, neverthelefs, very different; the heavieft ftones which are unmetallic being much lighter than the lighteft metals. A cubic foot of marble weighs 252 pounds; and an equal bulk of tin, the lighteft of metals, weighs 516 pounds. The difference is much greater when the weight of fuch a ftone is compared with that of gold, a cubic foot of which is 1326 pounds.

Opacity is another quality which metals poffefs eminently, the opacity of metals being much greater than that of any unmetallic fubftance.

This great opacity of metals is a confequence of their denfity; and thefe two properties produce a third, peculiar alfo to metals, namely, a capacity of reflecting much more light than any other body: hence metals whofe furfaces are polifhed, form mirrors reprefenting the images of bodies more clearly than any other matter. Thus looking-glaffes produce their reflexion merely by the filvering, which is a covering of metal upon their furfaces. To this reflective property metals owe their peculiar luftre, called the *metallic luftre*.

Although the feveral metallic fubftances differ confiderably in hardnefs and fufibility, we may fay in general, that they are lefs hard and lefs fufible than pure earths.

Metals cannot unite with any earthy fubftance, not even with their own earths, when thefe are deprived of their metallic ftate: hence, when they are melted, they naturally run into globes, as much as the abfolute gravity of their mafs, and their preffure upon the containing veffels, will allow. Accordingly, the furface of a metal in fufion is always convex. A metal in that ftate always endeavours to acquire a fpherical form, which it does more perfectly as the mafs is lefs. This effect is very fenfible in quickfilver, which is nothing but a metal habitually fluid or fufed. A mafs of feveral pounds of mercury, contained in a fhallow widemouthed veffel, is fo fpread out, that its upper furface is almoft flat, and the convexity is not very fenfible but at its circumference: on the contrary, if we put very fmall maffes of mercury into the fame veffel, as, for inftance, maffes weighing a grain each, they become fo round as to feem perfect globes. This effect is partly occafioned by the inaptitude of metals to unite with the veffels containing them when in fufion, by which quality the whole affinity which fubfifts betwixt the integrant parts of thefe metals is capable of acting; and partly alfo by this affinity, which difpofes the integrant parts to come as near to each other as they can, and confequently to form a fphere.

This property is not peculiar to melted metals, but to all fluids, when contiguous to bodies folid or fluid, with which they have no tendency to unite. Thus, for inftance, maffes of water upon oily bodies, or oily maffes upon bodies moiftened with water, affume always a form fo much nearer to the fpherical as they are fmaller. Even a large drop of oil poured upon a watery liquor, fo that it fhall be furrounded with this liquor, becomes a perfect fphere.

All metals are in general foluble by all acids; but often thefe folutions require particular treatment and circumftances, which are mentioned under CHEMISTRY, fect. iv. With acids, they form a kind of neutral falts, which have all more or lefs caufticity. The affinity of metals is lefs than of abforbent earths and alkaline falts to acids; and therefore any metal may be feparated from any acid by thefe earthy and faline alkalis.

Alkaline falts are capable of acting upon all metallic fubftances, and of keeping them diffolved by proper management.

Metals may in general be united with fulphur and liver of fulphur. With fulphur, they form compounds refembling the peculiar fubftance of ores, which are generally nothing elfe than natural combinations of fulphur and metal. Metals have lefs affinity with fulphur than with acids; hence fulphur may be feparated from them by acids. Some exceptions from thefe general rules, concerning the affinity of metals to fulphur and liver of fulphur, and concerning their feparation from fulphur by acids, may be feen under the articles of the feveral metals. But thefe exceptions do probably take place, only becaufe we have not yet found the method of furmounting fome obftacles which occur in the ordinary methods of treating certain metals.

All metals may in general be united with each other, with which they form different allays which have peculiar properties; but this rule alfo is not without fome exceptions.

Metals have ftrong affinity with the inflammable principle, and are capable of receiving it fuperabundantly.

Laftly, oily fubftances feem to be capable of acting upon all metals. Some metals are eafily and copioufly diffolved by oils; and perhaps they might all be found to be entirely foluble in oils, if the methods known in chemiftry were tried for the accomplifhment of thefe folutions.

The properties abovementioned agree in general to all metallic fubftances: but, befides the properties peculiar to each metal, fome properties are common to a certain number of them; and hence they have been divided into feveral claffes.

Thofe metallic matters which, when ftruck by a hammer, or ftrongly compreffed, are extended, lengthened,

ened, and flattened, without being broken, (which property is called *ductility* or *malleability*), and which also remain fixed in the most violent and long continued fire, without diminution of weight, or other sensible alteration, are called *perfect metals*. These perfect metals are three; *gold*, *silver*, *platina*.

The metallic matters which are ductile and fixed in the fire, to a certain degree, but which are destroyed by the continued action of fire, that is, changed into an earth deprived of all the characteristic properties of metals, are called *imperfect metals*. Of this kind are four; *copper*, *iron*, *tin*, *lead*.

The metallic substances which, as well as the imperfect metals, lose their metallic properties by exposure to fire, but which also have no ductility nor fixity, are distinguished from the others by the name of *semi-metals*. Of this class are five; *regulus of antimony*, *bismuth*, *zinc*, *regulus of cobalt*, and *regulus of arsenic*.

Lastly, *mercury*, which has all the general properties of metals, makes a class separate from the others; because in purity and gravity it is similar to the perfect metals, and in volatility to the semi-metals. Its fusibility also so far surpasses that of any other metallic matter, that it is sufficient to distinguish it from all, and to give it a distinct class. We have enumerated, therefore, in all, 13 metallic substances; two of which only were unknown to the ancients, namely, platina and regulus of cobalt. We have reason to wonder that these two metallic bodies, and particularly platina, which is a perfect metal, should have remained unknown till lately.

This may give us cause to hope, that if natural history and chemistry be carefully cultivated, as they have been since the renovation of the sciences, we may still make essential discoveries in this way. Mr Cronstedt has given, in the Swedish Memoirs, a description of a metallic matter, which, as he says, appears to be a new semimetal distinct from the others. In that case, this would be the fourteenth metallic matter known, and the third lately discovered: but as, since the Memoir of Mr Cronstedt, this new semimetal has not been examined by chemists, it is yet but little known; and therefore further experiments seem requisite to decide whether it ought to be admitted as a new semimetal (A).

As chemists can only know compound bodies by being capable of separating the principles of such bodies, and even of re-uniting their principles so as to reproduce such compounds as they were originally; and as hitherto they have not been able to accomplish any such decomposition upon the perfect metals; hence, if all the other metallic substances were equally unalterable, we should be very far from having certain notions concerning metals in general: but if we except gold, silver, and platina, all the other metallic matters are susceptible of decomposition and of recomposition, at least to a certain degree; and the experiments of this kind made by chemists, and chiefly by the modern chemists, have thrown much light on this important subject.

We may observe, that even if we had not been able to decompose any metallic substance, we might still, by reflecting on the essential properties of metals, discover sufficiently well the nature of their principles.

The solidity, the consistence, and especially the gravity, which they possess in a degree so superior to all other bodies, would not have allowed us to doubt that the earthy element, of which these are the characteristical properties, enters largely into their composition, and makes their basis.

The facility with which they combine with almost all inflammable matters, and with all those which have great affinity with phlogiston, such as acids; joined to their incapacity of being allayed with meagre matters that are purely earthy or purely watery, which have no disposition to unite with phlogiston; would also have furnished very strong motives to believe, that the inflammable principle enters largely into the composition of metals.

We must acknowledge, however, that these considerations would only have furnished concerning the existence of the inflammable principle in metals, but a simple probability, very far from the complete proof we now have: but the combustibility of all metals capable of decomposition by this method, and of the subsequent reduction, with all their properties, by the rejunction of the inflammable principle, furnishes the clearest and the most satisfactory demonstration that we have in chemistry. We shall now mention what is known upon this subject, and the consequences necessarily resulting.

The destructible metals present exactly the same phenomena as all other bodies containing the inflammable principle do, in the state of combustion. When exposed to fire, without access of air, that is, in close vessels, they become red-hot, melt, or sublime, according to their nature: but they receive no alteration in their composition from fire applied in this manner, and they are afterwards found to be exactly in the same state as before. In this respect, they resemble perfectly all bodies which contain no other inflammable matter than pure phlogiston.

But when imperfect metals are exposed to fire, with access of air, as, for instance, under a muffle in a furnace which is made very hot, then they burn more or less sensibly, as their inflammable principle is more or less abundant, or more or less combined. Some of them, as iron and zinc, burn with a very lively and brilliant flame; but this flame is of the same nature as that of charcoal, of sulphur, of all bodies, the combustible principle of which is pure phlogiston, and is not in an oily state, that is, furnishes no soot capable of blackening.

Also the imperfect metals detonate with nitre, when all the circumstances which that detonation requires are united *. Their phlogiston is consumed by this method much more quickly and completely than by ordinary calcination or combustion. Their flame is also much more lively and brilliant; and some of them, as iron and zinc, are used in compositions for fireworks, from their very vivid and beautiful flame.

* See *Detonation*.

Nitre is alkalised by these metallic detonations exactly in the same manner as in its detonation by coals.

Lastly,

(A) See NICKEL. Mr Justi pretends that he has discovered a new metallic substance contained in yellow mica. This, he says, was of a blackish grey colour; but when mixed with gold heightened the lustre, without destroying the malleability of that metal, though itself is brittle.

Of Metallization.

Lastly, imperfect metals being treated with acids which have an affinity with phlogiston, that is, with the vitriolic and nitrous acids, are deprived also by these acids of a more or less considerable part of their inflammable principle; they give a sulphureous quality to vitriolic acid, and are even capable of furnishing sulphur with that acid.

Although the experiments now mentioned were the only proofs of the existence of an inflammable principle in metallic substances, these would be sufficient to establish it incontestably. But we shall see, when we continue to examine the phenomena attending the decomposition of metals, that those are not the only proofs.

If the inflammable matter which shews itself so evidently in the burning of metals, is really one of their constituent parts, their essential properties must be altered in proportion to the quantity of it taken from them: and this evidently happens upon trial; for the residuum of metallic matters, after calcination, departs from the metallic character, and approaches to the nature of mere earth. The opacity, brilliancy, ductility, gravity, fusibility, volatility, in a word, all the properties by which metallic substances differ from simple earths, diminish or entirely disappear, by taking from them their inflammable principle; so that when their calcination has been carried as far as is possible, they resemble mere earths, and have no longer any thing in common with metals. These earths can no longer be combined with acids or with metals, but are capable of uniting with pure earths. They are then called *calxes* or *metallic earths*. See CHEMISTRY, n° 44, 45.

We must observe concerning the decomposition of metals, 1. That when only a small quantity of inflammable principle is taken from metals, a small quantity only of calx is formed, and the remaining part continues in the metallic state: hence, as the portion of calcined metal can no longer remain united with the undestroyed metal, it separates in form of scales from the surface of the metal when the calcination has been performed without fusion, as generally happens to iron and to copper; or these scales float upon the surface of the melted matter when the calcination is performed during fusion, because the calx is specifically lighter than the metal; as happens to the very fusible metals, as tin, lead, and most of the semimetals.

2. The imperfect metals are not all equally easily and completely calcinable. In general, as much of their phlogiston may be easily taken from them, as is sufficient to deprive them of their metallic properties; but the remaining portion of their phlogiston cannot be so easily driven from them. Some of them, as copper, resist the first calcination more than the rest; and others, as lead and bismuth, may be very easily calcined, but only to a certain degree, and retain always obstinately the last portions of their inflammable principle; lastly, others, as tin and regulus of antimony, may not only be easily and quickly calcined, but also much more completely. All the other metals partake more or less of these properties relating to their calcination. In general, if we except the labours of alchemists, which are not much to be depended upon, we have not yet made all the proper efforts to arrive at a perfect calcination of the several metallic substances; which, however, is absolutely necessary, before we can arrive at a complete knowledge of the nature of their earths, as we shall afterwards see.

When metallic earths have lost but little of their phlogiston, and are exposed to strong fire, they melt, and are reduced to compact masses, still heavy and opake, although much less so than the metals, and always brittle and absolutely unmalleable. If the calcination has been more perfect, the metallic earths are still fusible by fire, but less easily, and convertible into brittle and transparent masses possessed of all the properties of glass, and are accordingly called *metallic glasses*. These glasses do not possess any of the properties of their metals, excepting that they are specifically heavier than other glasses, that they are capable of being attacked by acids, and that the glasses of the semimetals are somewhat less fixed than unmetallic glasses. Lastly, when the calcinaton of metals has been carried to its greatest height, their earths are absolutely fixed, and unfusible in the fire of our furnaces, and possess no longer the solubility in acids by which metals are characterised.

These are the principal changes which metals suffer by losing their phlogiston. They are thus changed into substances which have no properties but those of earth. This is a certain proof that the inflammable principle is one of their constituent parts. But we have also other proofs of this important truth. The reduction of metallic calxes into metal, by the addition of phlogiston alone, completes the proof; and the whole forms one of the clearest and most satisfactory demonstrations in all the sciences. This reduction is effected in the following manner.

If the earth of a metal be mixed with any inflammable matter, which either is or can be changed into the state of coal, together with some salt capable of facilitating fusion, but which, from its quantity or quality, is incapable of receiving the inflammable principle; and if the whole be put into a crucible, and the fusion promoted by a fire gradually raised; then an effervescence will happen, accompanied with a hissing noise, which continues a certain time, during which the fire is not to be increased; afterwards, when the whole has been well fused, and the crucible taken from the fire and cooled, we shall find at the bottom, upon breaking it, the metal, the earth of which was employed for the operation, possessed of all the properties which it had before calcination and reduction. See REDUCTION.

We cannot doubt that this wonderful transformation of an earthy substance into a metal, is solely caused by the phlogiston passing from the inflammable matter to the metallic earth: for, first, in whatever manner and with whatever substance metallic earths be treated, they cannot be ever reduced into metals without a concurrence of some substance containing phlogiston. 2dly, The nature of the substance which is to furnish phlogiston is quite indifferent, because this principle is the same in all bodies containing it. 3dly, If, after the operation, the substance furnishing the phlogiston be examined, we shall find that it has lost as much of that principle as the metallic earth has received.

The facts related concerning the decomposition and the recomposition of metals prove incontestably, that they are all composed of earth and phlogiston. But we do not yet certainly know whether these two be the only principles of metals. We might affirm this, if we could produce metals by combining phlogiston with some matter which is certainly known to be simple earth.

earth. But this hitherto has not been accomplished; for if we try to treat any earth, which has never been metallic, with inflammable matters, we shall perceive that the simple earths are not combinable with phlogiston so as to form metals. We shall even perceive that the metallic earths resist this combination, and are incapable of reduction into metal, when they have been so much calcined as very nearly to approximate the nature of simple earths.

These considerations, added to this, that we cannot easily conceive how, from only two certain principles, so many very different compounds as the several metallic substances are, should result, are capable of inducing a belief that some other principle is added to these two already mentioned in the composition of metals.

Many great chemists, and particularly Becher and Stahl, seem to be convinced of this opinion; and chiefly from the experiments concerning the mercurification of metals, they believe that this third principle exists copiously in mercury; that it is of a mercurial nature; that it also exists in marine acid, to which it gives its specific character; that by extracting this mercurial principle from marine acid, or any other body containing it copiously, and by combining it with simple earths, these may acquire a metallic character, and be rendered capable of receiving phlogiston, and of being completely metallised.

These chemists admit also, and with probability, a different proportion of metallic principles in the several metals; and believe, that particularly the principle which they call *mercurial earth*, exists more copiously and sensibly in certain metals than in others. The most mercurial metals, according to them, are mercury, silver, lead, and arsenic. Most chemists distinguish from the other metals, silver, mercury, and lead; which they call *white metals*, *lunar metals*, or *mercurial metals*.

All these considerations being united, and others too many to be mentioned, give some probability to the existence of the mercurial principle in metals. We must however acknowledge, that the existence of this principle is only merely probable; and, as Stahl observes, is not nearly so well demonstrated as that of the inflammable principle: we may even add, that we have strong motives to doubt of its existence.

To produce metals artificially has justly been reckoned one of the most difficult problems in chemistry. The reflections we shall add upon this subject will be sufficient demonstration to every sensible person, that great knowledge is requisite in that science, to attempt with any hopes of success the production even of the most imperfect semimetal. Even if we were certain that it depends only on the intimate combination of the inflammable principle with a matter simply earthy, we should labour by chance, and without any reasonable expectation of success, if we were to attempt that combination without having more knowledge than we now possess, concerning the true nature of the earthy principle which enters into the composition of metals; for we must acknowledge that chemistry has made but little progress in this matter.

Metallic substances, although they resemble each other by the general properties mentioned in the beginning of this article, differ nevertheless from each other very evidently by the properties peculiar to each. Do these differences proceed from the different proportion, and from the more or less intimate connection of the inflammable principle with the earthy principle; supposing that this latter should be essentially the same in all metals? or ought they to be attributed to the difference of earths, which in that case would be distinct and peculiar to each metal? or, lastly, do metals differ from each other, both by the nature of their earths, and by the proportion and intimacy of connection of their principles? All these things are entirely unknown; and we may easily perceive, that till they are known, we cannot discover what method to pursue in our attempts to accomplish the combinations we are now treating of.

The most essential point then is, to arrive at a knowledge of the true nature of the earths which are in metals; and the only method of arriving at this knowledge is, to reduce them to their greatest simplicity by a perfect calcination. But this cannot be accomplished but by long and difficult operations. We have seen above, that all metals are not calcinable with equal ease; that the perfect metals have not been hitherto calcined truly by any process; and that in general, the last portions of phlogiston adhere very strongly to calcinable metals.

Some metals, however, as tin and regulus of antimony, may be easily calcined so as to be rendered irreducible. By carrying the calcination still further by the methods known in chemistry, we might obtain their earths so pure, that all their essential properties may be discovered, by which they might be easily compared together. This comparison would decide whether their nature be essentially different or not.

If they were found to be composed of earths essentially the same, we might next proceed to compare metallic with unmetallic earths. If the former were found similar to some of the latter kind, we should be then assured that the earth of metals is not peculiar to them, and that ordinary unmetallic earths are susceptible of metallisation.

The greater the number of metals operated upon, the more general and certain the consequences resulting from these would be: so that, for instance, if the operation were extended to all calcinable metals; and if the result of each of these operations were, that the calxes, when perfectly dephlogisticated, do not differ from each other, and are similar to earths already known; we might conclude from analogy, and we should be almost certain, that the earths of the perfect metals are also of the same nature.

They who know the extent and difficulties of chemical operations, will easily perceive that this would be one of the most considerable. Nevertheless, after having determined this essential point, we should only have done half our work. For a knowledge of the nature of the earth of metals, and where it is to be found, would not be sufficient; we must further endeavour to find a method of combining with this earth a sufficient quantity of phlogiston, and in a manner sufficiently intimate, that a metal might be formed by such a combination. But this second difficulty is perhaps greater than the former.

We must observe here, that some famous chemical processes have been considered by many as metallisations, but which are really not so. Such is Becher's famous experiment of the *minera arenaria perpetua*, by

Of Metallization.

by which that chemift propofed to the States General to extract gold from any kind of fand. Such alfo is the procefs of Becher and of Geoffroy, to obtain iron from all clays by treating them with linfeed oil in clofe veffels. In thefe, and many other fuch proceffes, we do only obtain metal that was already formed. Every earth and fand, as the intelligent and judicious Cramer obferves, contain fome particles of gold. Clays do not commonly contain iron ready formed; but all of them contain a ferruginous earth, naturally difpofed to metallifation. See CLAY. Accordingly we muft conclude, that, by Mr Geoffroy's experiment, iron is only reduced or revived, but is not produced.

The great difficulties which occur in attempting to give a metallic quality to fimple earths have induced a belief, that the nature of metals ready formed might be more eafily changed, and the lefs perfect brought to a more perfect ftate. To effect this, which is one of the principal objects of alchemy, and is called *tranfmutation*, numberlefs trials have been made. As we have not any certain knowledge of what occafions the fpecific differences of metallic fubftances, we cannot decide whether tranfmutation be poffible or not. In fact, if each metallic fubftance have its peculiar earth, effentially different from the earths of the others, and confequently if the differences of metals proceed from the differences of their earths; then, as we cannot change the effential properties of any fimple fubftance, tranfmutation of metals muft be impoffible. But if the earths and other principles of metals be effentially the fame, if they be combined in different proportions only, and more or lefs ftrictly united, and if this be the only caufe of the fpecific difference of metals, we then fee no impoffibility in their tranfmutation.

Whatever be the caufe of the differences of metals, their tranfmutation feems to be no lefs difficult than the production of a new metallic fubftance; and perhaps it is even more difficult. Alchemifts believe that tranfmutation is poffible, and they even affirm that they have effected it. They begin by fuppofing that all metals are compofed of the fame principles; and that the imperfect metals do not differ from gold and filver, but becaufe their principles are not fo well combined, or becaufe they contain heterogeneous matters. We have then only thefe two faults to remedy, which, as they fay, may be done by a proper coction, and by feparating the pure from the impure. As we have but very vague and fuperficial notions concerning the caufes of the differences of metals, we confefs that we cannot make any reafonable conjecture upon this matter; and we fhall only advife thofe who would proceed upon good principles, to determine previoufly, if metals have each a peculiar earth, or only one common to them all. In the fecond place, if it fhould be demonftrated that the earthy principle is the fame in all metals, and if that be demonftrated as clearly as the identity of the inflammable principle in metals is proved; they muft then determine whether thefe two be the only principles in metals, whether the mercurial principle exifts, and whether it be effential to all metals or to fome only, and what is the proportion of thefe two or three principles in the feveral metallic fubftances. When we fhall clearly underftand thefe principal objects, we may then be able to determine concerning the poffibility of tranfmutation; and if the poffibility fhould be affirmed, we fhall then begin to difcover the road which we ought to purfue.

We have no reafon to believe that any other principle enters into the compofition of metals than thofe above-mentioned: no veftige is perceptible of either air or water. Some chemifts have neverthelefs advanced that they contain a faline principle. If that were true, they would alfo contain a watery principle. But all the experiments adduced to prove this opinion are either falfe, or only fhow the prefence of fome faline particles extraneous to the metals, or contained unknown to the chemifts in the fubftances employed in the experiments. For metals perfectly pure, fubjected to all trials with fubftances which do not contain and which cannot produce any thing faline, do not difcover any faline property. We muft however except arfenic, and even its regulus, thefe being fingular fubftances, in which the faline are as fenfible as the metallic properties.

Arfenic feems to be one of thofe intermediate fubftances which nature has placed in almoft all its productions betwixt two different kinds, and which partake of the properties of each kind. Arfenic thus placed betwixt metallic and faline fubftances has properties common to both thefe kinds of fubftances, without being either entirely a metal or falt. See ARSENIC.

As water feems to act to a certain degree upon iron, even without the concurrence of air, as the operation of *martial ethiops* fhews, we might thence fufpect fomething faline in that metal. Neverthelefs, what happens in that operation has not been fo well explained, that any certain confequences can be deduced. 1. The water employed ought to be perfectly pure; that is, diftilled rain-water. 2. The iron employed ought alfo to be perfectly pure, and fuch is very difficultly to be procured. 3. The operation ought to be performed in a bottle accurately clofed, that we may be affured that the air contributes nothing to the action upon the iron. 4. After the water has remained a long time, fuppofe a year, upon the iron, the water ought to be carefully filtrated and examined, to afcertain whether it really has diffolved any part of the metal.

In the mean time, we may conclude that metals do not feem to contain any faline principle. And when we confider well their general properties, they feem to be nothing elfe than earths combined more or lefs intimately with a large quantity of phlogifton. Although we can demonftrate that their inflammable principle is not in an oily ftate, and that it is pure phlogifton, they have neverthelefs an oily appearance, in this circumftance, that they adhere no more than oils to earthy and aqueous fubftances, and that they always affume a globular figure when fupported by thefe fubftances entirely free from phlogifton.

This refemblance is fo fenfible, that chemifts, before they knew the nature of phlogifton, believed that metals contained an oily and fat matter; and even now many perfons, who talk of chemiftry without underftanding it, fpeak of the *oil* or *fat* of *metals*; expreffions, which do not found well to genuine chemifts. The caufe of this quality of metals is the quantity of phlogifton which they contain. Sulphur, phofphorus, oils, and even fats, have this appearance

merely from the inflammable principle which enters into their compofition: for this property is communicated by that principle to every compound which contains a certain quantity of it. See PHLOGISTON.

When the phlogifton combines copioufly and intimately with earthy matters fo as to form metals, it probably fo difpofes them, that the primitive integrant parts of the new compound, that is, of the metal, approximate and touch each other much more than the integrant parts of fimple earths can. This is proved by the great denfity or fpecific gravity, and other general properties, of metals.

In fact, as we cannot conceive that a body fhould be tranfparent, unlefs it have pores and interftices through which rays of light can pafs; therefore the more denfe a body is, that is, the fewer fuch interftices it has, the lefs tranfparent it will be; fo that the denfeft bodies ought to be the moft opake, as in metals. The difpofition of the pores of bodies contributes alfo much to their greater or lefs tranfparency; and bodies, the pores of which are continued and ftraight, are more tranfparent than thofe whofe pores are interrupted, tranfverfe, or oblique; fo that a body may be much more tranfparent than another which is lefs denfe, as we fee that glafs is more tranfparent than charcoal. But when other circumftances are equal, the denfeft bodies are the moft opake. Therefore the opacity of bodies is proportionable to their denfity, and to the deviation of their pores from right and parallel lines.

From the great opacity of metals, they probably poffefs both thefe qualities in an eminent degree. We have feen, at the beginning of this article, that the luftre of metals, and their property of reflecting light much better than any other fubftance, are neceffary confequences of their opacity. This is alfo felf-evident, becaufe the fewer rays any body can tranfmit, the more it muft reflect.

Laftly, the ductility of metals proceeds alfo from their denfity, and from the difpofition of their pores. Phlogifton alfo appears to communicate ductility to moft of the bodies containing it; as we fee in fulphur, and in unctuous bodies, as refins, wax, &c. all which are more or lefs ductile, at leaft when heated to a certain degree. Laftly, the foftnefs, fufibility, and volatility, of which all metals partake more or lefs, and which many of them poffefs in a fuperior degree, being properties entirely contrary to thofe of the earthy principle, probably proceed from the inflammable principle. In general, if we reflect on the effential properties of the earthy and inflammable principles, we fhall eafily perceive that thefe properties, being combined and modified by each other, ought to produce the properties of metals.

The order in which metals compared with each other poffefs moft eminently their principal properties, is the fame as that in which they are here enumerated, according to Mr Macquer, beginning always with that metal in which the property is moft confiderable.

1. *Specific gravity* or *denfity*. Gold, platina, mercury, lead, filver, copper, iron, and tin.

2. *Opacity*. We cannot well compare metals with each other in this refpect, becaufe it is fo confiderable in all, that it feems complete. If, however, they differ in this refpect, the fame order will ferve for opacity as for denfity.

3. *Metallic luftre* or *brilliancy*. The fame obfervation which was made concerning the laft-mentioned property is applicable to this alfo. We muft however obferve, that as by polifh bodies are rendered brighter, and that as whitenefs contributes much to the reflexion of light, the whiteft and hardeft metals therefore reflect beft. Hence, according to Mr Macquer, platina ought to be placed firft; and then iron, or rather fteel, filver, gold, copper, tin, lead.

Hardnefs of metals may contribute much to the duration of their polifh; but certainly foft metals, if their texture be equally compact, are no lefs capable of receiving a polifh than hard metals. Some hard metallic allays have been found to be lefs liable to tarnifh than fofter compounds, and have for this reafon alfo been chiefly ufed for fpeculums. The property of reflecting light feems chiefly to depend on the clofenefs of the particles, or on the denfity, on the fmoothnefs of the furface, and on the colour being moft fimilar to the colour of the light to be reflected. The white metals, filver, mercury, tin, reflect light more abundantly than others. Gold, being the denfeft metal, and perhaps becaufe the colour of folar light has a flightly-yellowifh tinge, does alfo reflect light very copioufly. Hence fpeculums made of leaf-gold have been found to be very effectual. Iron or fteel reflects much lefs light than any of the above-mentioned metals, altho' Mr Macquer has confidered it as capable of a greater reflective power. Platina is generally in fo fmall grains, that its reflective power cannot eafily be determined. The precife degrees of that power which ought to be affigned to each of the above-mentioned metals, cannot without accurate experiments be afcertained. Perhaps, however, their reflective powers will be found to be more nearly in the following order, than in that abovementioned from Mr Macquer. Silver, quickfilver, tin, gold, copper, iron, lead.

4. *Ductility*. Gold, filver, copper, iron, tin, lead. The ductility of mercury and that of platina are not yet determined.

5. *Hardnefs*. Iron, platina, copper, filver, gold, tin, and lead.

6. *Tenacity*. By tenacity we underftand the force with which the integrant parts of metals refift their feparation. This force appears to be in a compound ratio of their ductility and hardnefs. The comparative tenacity of metals is meafured by the weight which wires of the fame diameter, made of the feveral metals, can fuftain without breaking. Gold is the moft tenacious, then iron, copper, filver, tin, lead. The tenacity of mercury is unknown: that of platina is not yet determined, but is probably confiderable.

7. *Fufibility*. Mercury, tin, lead, filver, gold, copper, iron, and laftly platina, which cannot be fufed by the greateft fire of our furnaces, but only by the folar focus, as Meffrs Macquer and Beaumé have determined.

SECT. II. *Of Mines and Ores in general.*

THE fubftances found naturally combined with metals, in the earth, are, particularly, fulphur and arfenic, fometimes feparately, but generally conjointly.

Me-

Metals combined with theſe ſubſtances are called *metals mineraliſed by ſulphur*, or *by arſenic*, or *by ſulphur and arſenic;* and theſe matters are called *mineraliſing* ſubſtances.

Beſides the ſulphur and arſenic with which metals are ſtrictly combined in the mineral ſtate, they are alſo pretty intimately combined with earthy ſubſtances, of different natures, and more or leſs divided.

Theſe different matters united together form maſſes which are compact, heavy, brittle, and frequently poſſeſſed of much metallic luſtre. Theſe ſubſtances are properly called *ores*, or the matter of mines.

Theſe ores are found in earths and ſtones of different kinds, as ſands, flints, cryſtals, ſlates, indurated clays, according to the ground in which they are contained. But two kinds of ſtones in particular ſeem to accompany ores; and have therefore been conſidered by ſeveral mineralogiſts as matrixes, in which metals are formed. One of theſe ſtones is a kind of cryſtal, generally white, milky, and ſemi-opake, ſtriking fire with ſteel, and of the claſs of vitrifiable earths. It is called QUARTZ.

The other ſtone is leſs hard, which does not ſtrike fire with ſteel, and is ſometimes milky like quartz; ſometimes tranſparent and diverſely coloured, conſiſting of rhomboidal cryſtals, which are compoſed of plates and faces. This ſtone becomes more ſoft and friable by being expoſed to fire. It is called *ſpar.* Spar is more like to gypſeous ſtones than to any other, but it differs from gypſeous ſtones in poſſeſſing a much greater denſity. Some ſpars are ſo heavy, that they exceed in this reſpect all other ſtones. See SPAR.

Theſe earthy and ſtony ſubſtances form the *matrix of the ore.*

Ores are natural compounds, containing metals allayed with different ſubſtances.

Excepting gold, and a very ſmall quantity of each of the other metals found in ſome places ſo pure as to poſſeſs all their characteriſtic properties, nature exhibits to us metals and ſemimetals differently allayed not only with each other, but alſo with ſeveral heterogeneous ſubſtances, which ſo alter and diſguiſe their qualities, that in this ſtate they cannot ſerve for any of the purpoſes for which they are proper when they are ſufficiently pure.

Ores conſiſt, 1. Of metallic ſubſtances *calcined;* or, 2. Of theſe ſubſtances combined with other matters, with which they are ſaid to be *mineraliſed.*

Calcined metallic ſubſtances, or *calciform ores*, are metallic ſubſtances deprived of phlogiſton, and in the ſtate of a calx or metallic earth. Such are all *ferruginous ochres*, which are calxes of iron.

Mineraliſed ores, are, 1. *Simple*, containing only one metallic ſubſtance: or, 2. *Compound*, containing two or more metallic ſubſtances.

Of the ſimple, and alſo of the compound ores, four kinds may be diſtinguiſhed.

1. Ores conſiſting of metallic ſubſtances mineraliſed by *ſulphur.* Such is the lead-ore called *galena*, compoſed of lead and ſulphur.

2. Ores conſiſting of metallic ſubſtances mineraliſed by *arſenic.* Such is the *white pyritis*, containing iron and arſenic.

3. Ores conſiſting of metallic ſubſtances mineraliſed *by ſulphur and by arſenic.* Such is the *red ſilver-ore*, containing ſilver, arſenic, and ſulphur.

4. Ores conſiſting of metallic ſubſtances mineraliſed by *ſaline matters.* Such are the *native vitriols.* Such alſo is probably the *corneous ſilver-ore*, which, according to Mr Cronſtedt's opinion, is a luna cornea, or ſilver combined with marine acid. Of this kind of ores, or native metallic ſalts, is perhaps the *ſedative ſalt of borax*, which from Mr Cadet's experiments, publiſhed in the Memoirs of the Royal Academy for the year 1766, is conjectured to be copper combined with marine acid, and which has been ſaid to be found native. To this claſs alſo may be referred the *ſilver mineraliſed by an alkaline ſubſtance*, which Mr Von Juſti pretends to have diſcovered.

Henckel, and after him Cramer, and the author of the Dictionary of Chemiſtry, pretend, that in mineraliſed ores, beſides the above-mentioned metallic and mineraliſing ſubſtances, are alſo contained a metallic and an unmetallic earth. But Wallerius affirms, that the exiſtence of ſuch earths cannot be ſhewn, and that ſulphur is incapable of diſſolving unmetallic earths, and even the calxes of all metallic ſubſtances, excepting thoſe of lead, biſmuth, and nickel.

Having thus defined and diſtinguiſhed the ſeveral general claſſes of ores, we proceed to ſhew how they are lodged, and where they are found.

Metals and *metalliferous ores are found* in various places.

I. They are found *under water;* in beds of rivers, lakes, and ſeas, and chiefly at the flexures of theſe: ſuch are the auriferous and ferruginous ſands, grains of native gold, ochres, and fragments of ores waſhed from mines.

II. They are found *diſſolved in water:* ſuch are the vitriolic waters containing iron, copper, or zinc.

III. They are found *upon the ſurface of the earth.* Such are many ochres; metalliferous ſtones, ſands, and clays; and lumps of ores. Mr Gmelin ſays, that in the northern parts of Aſia ores are almoſt always found upon or near the ſurface of the ground.

IV. They are found *under the ſurface of the earth.* When the quantity of theſe collected in one place is conſiderable, it is called a *mine.*

Subterranean metals and ores are differently diſpoſed in different places.

1. Some are *infixed in ſtones and earths*, formed *nodules* or *ſpots* diverſely coloured.

2. Some are equably and *uniformly diffuſed through the ſubſtance of earths and ſtones*, to which they give colour, denſity, and other properties. Such are the greateſt part of thoſe earths, ſtones, ſands, clays, cryſtals, flints, gems, and fluors, which are coloured.

3. Some form *ſtrata* in mountains. Such are the ſlates containing pyrites, copper-ore, lead-ore, ſilver-ore, or blend. Theſe lie in the ſame direction as the ſtrata of ſtones betwixt which they are placed; but they differ from the ordinary ſtrata in this circumſtance, that the thickneſs of different parts of the ſame metalliferous ſtratum is often very various; whereas the thickneſs of the ſtony ſtrata is known to be generally very uniform.

4. *Fragments of ores* are frequently found accumulated in certain ſubterranean cavities, in fiſſures of mountains, or interpoſed betwixt the ſtrata of the earth.

earth. These are loose, unconnected, frequently involved in clay, and not accreted to the contiguous rocks or strata immediately, nor by intervention of spar or of quartz, as the ores found in veins are. Tin and iron mines are frequently of the kind here described.

5. Large entire masses of ores are sometimes found in the stony strata of mountains. These are improperly called *cumulated veins*, because their length, relatively to their breadth and depth, is not considerable.

6. Some instances are mentioned of *entire mountains* consisting of ore. Such is the mountain Taberg in Smoland; and such are the mountains of Kerunavara and Luosavara in Lapland, the former of which is 1400 perches long and 100 perches broad. These mountains consist of iron-ore.

9. Lastly, and chiefly, metals and ores are found in oblong tracts, forming masses called *veins*, which lie in the stony strata composing mountains.

The direction of veins greatly varies; some being straight, and others curved. Their position also respecting the horizon is very various; some being perpendicular, some horizontal, and the rest being of the intermediate degrees of declivity.

The dimensions, the quality, and the quantity of contents, and many other circumstances of veins, are also very various. Miners distinguish the several kinds of veins by names expressive of their differences. Thus veins are said to be *deep; perpendicular; horizontal*, or *hanging*, or *dilated; rich; poor; morning, noon, evening*, and *night* veins, by which their direction towards that point of the compass where the sun is at any of these divisions of the natural day, is signified.

The stratum of earth or stone lying above a vein is called its *roof:* and the stratum under the vein is called its *floor*.

Some parts of veins are considerably thicker than others. Small veins frequently branch out from large veins, and sometimes these branches return into the trunk from which they issued. These veins from which many smaller veins depart, have been observed to be generally rich.

Veins are terminated variously: 1. By a gradual diminution, as if they had been compressed, while yet soft, by superincumbent weight; or by splitting and dividing into several smaller veins. Or, 2. They are terminated abruptly, together with their proper strata in which they lie. This abrupt termination of veins and strata is occasioned by their being crossed by new strata running transversely to the direction of the former; or by perpendicular fissures through the strata; which fissures are frequently filled with alluvial matters, or with water, or are empty. These perpendicular fissures seem to have been occasioned by some rupture or derangement of the stratum through which the vein passes, by which one part of it has been raised or depressed, or removed aside from the other, probably by earthquakes. Where the veins are terminated abruptly, it does not cease, but is only broken and disjoined; and is often recovered by searching in the analogous parts of the opposite side of the deranged stratum. A principal part of the art of miners consists in discovering the modes of these derangements from external marks, that they may know where to search for the disjoined vein.

The *contents of veins* are metals and metalliferous minerals; as, the several kinds of ores, pyrites, blends, guhrs, vitriols; the several kinds of fluors, spars, quartz, horn-blend, in which the ores are generally embedded, or inveloped, and to which therefore the name *matrix of the ore* is applied; stalactites; crystallizations of these metalliferous and stony substances encrusting the small cavities of the circumjacent rock; and lastly, water, which flows or drops through crevices in that rock.

In a vein, ores are found sometimes attached to the rock or stratum through which the vein runs, but more frequently to a matrix which adheres to the rock; and sometimes both these kinds of adhesion occur in the same vein at different places. Frequently betwixt the matrix and the rock is interposed a thin crust of stone or of earth, called by authors the *fimbria of the ore*.

The *matrix* or the stone in which the ore lies inveloped is of various kinds in different veins. And some kinds of stone seem better adapted than others to give reception to any ore, or to the ores of particular metals. Thus quartz, spar, fluors, and hornblend, give reception to all ores and metals; but slates, chiefly to copper and silver, and never to tin; calcareous and sparry matrixes, to lead, silver, and tin; and mica to iron.

Veins lie in strata of different kinds of stone; but more frequently in some kinds of stone than in others. Thus of the simple or uncompounded stones which compose strata, the following are metalliferous: *Calcareous stones; slaty sand-stone* (cos fissilis arenosus Wallerii); *feltspar* (spatum pyrimachum sive scintillans); *quartz;* sometimes *jasper;* frequently *slates;* and chiefly *micaceous* or *talky* stones; and *hornblend*, (lapis corneus Wallerii; bolus indurata particulis squamosis Cronstedt). No veins have been found in gypseous or in siliceous strata, although *chertz* and *flints* frequently contain metallic particles, and some instances have been observed of ores of silver and of tin in *alabaster*. Of compound stones, those are said to be chiefly metalliferous which consist of particles of hornblend. Veins have also been found in the *red granite;* but seldom, if ever, in any other *granite*, or in *porphyry*. In general, veins are more frequently found in soft, fissile, and friable strata, than in those which are compact and hard.

A vein sometimes passes from one stratum into the inferior contiguous stratum. Sometimes even the veins of one stratum do so correspond with those of an inferior stratum, the contiguity of which with the former is interrupted by a mass of different matter thro' which the veins do not pass, that they seem originally to have been continued from one stratum to the other. Thus in the mines of Derbyshire, where the veins lie in strata of limestone, the contiguity of which strata with each other is interrupted in some places by a blue marle or clay, and in other places by a compound stone called *toadstone;* the veins of one stratum frequently correspond with the veins of the inferior stratum of limestone, but are never continued through the interposed clay or toadstone. But we must observe, that these interposed masses, the blue marle, clay, and toadstone, have not the uniform thickness ob-

obfervable in regular ftrata, but are (efpecially the toadftone) in fome places a few feet in depth, and in others fome hundreds of yards. The above difpofition feems to indicate, that thefe feveral ftrata of limeftone have been originally contiguous; that the veins now disjoined have been once continued; that thefe ftrata of limeftone have been afterwards feparated by fome violent caufe, probably by the fame earthquakes which have in a fingular manner fhattered the ftrata of this mountainous country; that the interftices thus formed between the feparated ftrata have been filled with fuch matters as the waters could infinuate, probably with the mixed comminuted ruins of fhattered ftrata; or with the lava of neighbouring volcanoes, of which many veftiges remain.

To the above hiftorical fketch of mines, we fhall add fome conjectural remarks concerning their *formation*.

Thofe ores which are found under water (I.); upon the furface of the earth (III.); in fiffures of mountains and fubterraneous cavities, accumulated, but not accreted to the contiguous rocks, (IV. 4.); feem from their loofe, unconnected, broken appearances, to have been conveyed by alluvion.

All martial ochres have probably been feparated from vitriolic ferruginous waters (II.) either fpontaneoufly or by calcareous earth; and thefe waters feem to have acquired their metallic contents by diffolving the vitriol which is produced by the fpontaneous decompofition of martial pyrites. The ochres of copper, zinc, and perhaps of feveral other metals, have probably been precipitated from vitriolic waters by fome fubftance, as calcareous earth, more difpofed to combine with acids; and thefe vitriolic waters have probably been rendered metalliferous, by diffolving the vitriols produced by a combuftion of cupreous pyrites and of the ore of zinc called *blend;* for thefe minerals are not, as martial pyrites is, fufceptible of decompofition fpontaneoufly, that is, by air and moifture.

The metalliferous nodules and fpots (IV. 1.) feem to have been infixed in ftones while thefe were yet foft. Perhaps the metalliferous and lapideous particles were at once diffolved and fufpended in the fame aqueous menftruum, and during their concretion cryftallized diftinctly, as different falts do when diffolved in the fame fluid.

The earths and ftones uniformly coloured by metals (IV. 2.) were alfo probably in a foft ftate while they received thefe tinges. The opake-coloured ftones feem to have received their colour from metallic calxes mixed and diffufed through the foft lapideous fubftance; and the tranfparent-coloured ftones have probably received their colours from vitriolic falts, or from metallic particles diffolved in the fame water which foftened or liquefied the ftony fubftance; which metallic falts and particles were fo much diffufed, that they could not be diftinctly cryftallized. That all ftones have been once liquid and diffolved in water, appears probable not only from their regular cryftallized forms, but alfo the folubility of fome ftones, as of gypfeous and calcareous earths, in water; and from the water which we know is contained in the hardeft marbles, as well as in alabafters; to which water thefe ftones owe the cryftallization of their particles.

The veins called *cumulated* (IV. 5.), and the entire metalliferous mountains (IV. 6.), are believed by Wallerius to be analogous to the nodules (IV. 1.) Thefe metalliferous fubftances feem to have been originally formed or concreted in the places where they are found.

The metalliferous ftrata (IV. 3.) have probably been infinuated between the lapideous ftrata, after the feparation of thefe from each other by fome violent caufe; in the fame manner in which we fuppofed that the clay and toadftone have been infinuated betwixt the feveral ftrata of lime-ftone in Derbyfhire. The matters thus infinuated may have been either fluid, which would afterwards cryftallize and form entire regular maffes; or they may have been the ruins of fhattered ftrata and veins brought by waters, and there depofited; in which cafe they will appear broken and irregular. The metalliferous ftrata, although frequently confounded with the horizontal or dilated veins, may be diftinguifhed, according to Wallerius, from thefe by the following properties: 1. They are generally thinner and much broader than the veins called *dilated*. 2. They are feldom found at a greater depth than 100 perches, and generally in the neighbourhood of veins from which they probably have received their contents. 3. From their want of the thin encruftations called *fimbriæ;* which, we obferved, are frequently interpofed betwixt the rock and the ore or its matrix; and from their want of the other properties of veins.

But in *veins* properly fo called, the ftrongeft marks exift of ores having been there concreted, and not carried thither and depofited in their prefent ftate. Their regular, unbroken appearance; their accretion to the contiguous rock, either immediately, or by intervention of a matrix; the regular appearance of this matrix inveloping the ore; the frequent cryftallization of the ore, and of the other contents of the vein, indicate that ores, as well as the other folid contents, have been there concreted from a fluid to a folid ftate.

Moft authors believe that veins, and the perpendicular clefts in the ftony ftrata of mountains, called *fiffures*, have been produced by the fame caufe; or rather, they confider veins only as fiffures filled with metalliferous matters. They further believe, that fiffures have been occafioned by the exficcation of ftrata, while thefe were paffing from a fluid to a folid ftate. Wallerius thinks, that fiffures have been formed from exficcation; but that veins were channels made through the ftrata, while yet foft and fluid, by water, or by the more fluid parts of the ftrata penetrating and forcing a paffage through the more folid parts. He thinks, that thefe fluid parts conveyed thither their metalliferous and ftony contents, which were there coagulated or concreted. He fupports his opinion by obferving, that all the veins of the fame ftratum generally run parallel to each other; that they frequently bend in their courfe; that the fame vein is fometimes contracted, and fometimes dilated; that veins are frequently terminated by being fplit, or divided into inferior veins; that veins are frequently wider at bottom than at top, whereas fiffures are always wideft at top, and are very narrow below; all which appearances, he thinks, could not have been produced by exficcation. From thefe reafons,

Formation of Mines.

sons, fissures appear to have had a different, and, from the disjunction and rupture of veins crossed by fissures, they seem to have had a later origin than veins. Whether fissures could have been produced by the very gradual exsiccation of these large masses of strongly coherent matter; or whether they have been produced by the same violent causes, namely, *earthquakes*, by which the strata in which fissures are generally found have been broken and deranged, and by which metalliferous mountains themselves have been formed, or their strata raised above their original level, as some authors have with great probability conjectured, we do not pretend to determine.

Veins are seldom, if ever, found but in mountains. The reason of which may not improbably be, that in metalliferous mountains we have access to the more ancient strata of the earth, which in plains are covered with so many deposited, alluvial, and other later strata, that we can seldom, if ever, reach the former. That these mountains consist of strata which have been originally lower than the upper strata of adjacent plains, appears from an observation which has been made, that the strata of mountainous countries dip with more or less declivity as they approach the plains, till they gradually sink under the several strata of those plains, and are at last immersed beyond the reach of miners. This leading fact in the natural history of the earth has been observed by a sagacious philosopher, Mr Mitchell, in his *Conjectures concerning Earthquakes*, Phil. Transf. 1760.

That the inferior strata of the earth contain large quantities of pyritous, sulphureous, and metalliferous matters, appears, 1. From the subterranean fires in those inferior strata, which produce volcanoes, and probably earthquakes, as Mr Mitchell ingeniously conjectures. 2. From the observation, that all kinds of mountains are not equally metalliferous; but that veins especially are only found in those mountains which, being composed of very ancient strata, are called *primæval*, which form the chains and extensive ridges on the surface of the earth, which direct the course of the waters, and which consist of certain strata, the thickness of each of which, its generic qualities, and its position relatively to the other strata, are, in different parts of the chain of mountains where that stratum is found, nearly uniform and alike, notwithstanding that the numbers and the inclinations of the strata composing contiguous mountains, or even different parts of the same mountain, are often very various; and therefore that veins are seldom, if ever, found in the mountains called by authors *diluvial* and *temporary*, which are single, or detached, which consist not of strata uniformly disposed, but of alluvial masses, in which fragments of ores may be sometimes, but veins never, found. Nevertheless, single and seemingly detached mountains, in small islands, have sometimes been found to be metalliferous. But we must observe, that these mountains consist of uniform strata; that islands themselves, especially small islands, may be considered as eminent parts of sub-marine ranges of mountains, and that the mountains of such islands may be considered as apices or tops only of inferior mountains.

Those mountains are said to be most metalliferous which have a gentle ascent, a moderate height, and a broad basis, the strata of which are nearly horizontal, and not much broken and disjoined. In these mountains at least the veins are less interrupted, more extended, and consequently more valuable to miners, than the veins in lofty, craggy, irregular, and shattered mountains.

Authors dispute concerning the time in which ores have been formed; some referring it to the creation of the world, or to the first subsequent ages; and others believing that they have been gradually from all times, and are now daily, formed. From the accretion of ores and of their matrices to their proper rocks, and from the insertion of metalliferous nodules and striæ in the hardest stones, we are inclined to believe that the matter of these veins and nodules are nearly coeval with the rocks and stones in which they are inveloped. Nevertheless, we cannot doubt that small quantities at least of ores are still daily formed in veins, fissures, and other subterranean cavities. Several well-attested instances confirming this opinion are adduced by authors: Cronstedt mentions an incrustation of silver-ore that was found adhering to a thin coat of lamp-black or of soot, with which the smoke of a torch had soiled a rock in a mine at Koningsberg in Norway; and that this incrustation of silver-ore had been formed by a metalliferous water passing over the rock. Lehman affirms, that he possesses some silver-ore attached to the step of a ladder found in a mine in Hartz, which had been abandoned 200 years ago; and that several steps of ladders similarly incrusted had been found. Many other instances are mentioned by authors, of galena, pyrites, silver-ores, and other metalliferous substances, having been found adhering to wood, to fossil-coal, to stalactitical incrustations, to oyster-shells, and other recent substances. From these, and from similar instances, it is probable, that not only ochres and fragments of ores may, with other alluvial matters, be now daily deposited, but also that small quantities of mineralized ores are recently formed; although many histories mentioned by Becher, Barba, Henckel, and other authors, of the entire renovation of exhausted veins, and especially those of the growth and vegetation of metals and of ores, appear to be at least doubtful.

Various opinions have been published concerning the formation of mineralized ores. According to some, these ores were formed by congelation of the fluid masses found in mines, called *Guhrs*. Other authors believe, that ores have been formed by the condensation of certain mineral, metallic, sulphureous, and arsenical vapours, with which they suppose that mines abound. Some have even affirmed, that they have seen this vapour condense, and become in a few days changed into gold, silver, and other metallic matters. It has been above observed, that from several appearances which occur in veins, there is great reason to believe, that ores have not been carried thither and deposited in their present state, but have been there *concreted* and *crystallized*; that is, changed from a fluid to a solid state. But the fluidity of the metalliferous matters at the time of their entrance into veins, may have been occasioned either by their having been *dissolved in water*, if they were capable of such solution, or by their having been raised in form of *vapour* by subterranean fires. For the disposition to crystallize is

is acquired by every homogeneous fubftance that is fluid, whether it has received its fluidity by being melted by fire, or by being diffolved in a liquid menftruum, or by being reduced to the ftate of vapour. Thus cryftals of fulphur have been obferved to be daily formed by the fulphureous vapours which exhale in the neighbourhood of volcanoes. The volatility of the two mineralifing fubftances fulphur and arfenic, and the power which volatile bodies poffefs of elevating a certain portion of any fixed matter which happens to be united with them, render it probable, that the greateft part at leaft of mineralifed ores have been formed of vapours exhaled from fubterranean fires, through the cracks in the intervening ftrata occafioned by thofe earthquakes which have, in a fingular manner, broke and deranged the ftrata of metalliferous countries, and which, as has been above remarked, have been probably occafioned by, at leaft have certainly been always accompanied with, fubterranean fires.

SECT. III. *Of the Pyrites.*

PYRITE is a mineral refembling the true ores of metals, in the fubftances of which it is compofed, in its colour or luftre, in its great weight, and, laftly, in the parts of the earth in which it is found, fince it almoft always accompanies ores. It is, like ores, compofed of metallic fubftances, mineralized by fulphur or by arfenic, or by both thefe matters, and of an unmetallic earth intimately united with its other principles.

Notwithftanding the conformity of pyrites with ores properly fo called, fome chemifts and metallurgifts diftinguifh the former from the latter minerals; becaufe the proportion and connection of the materials compofing the pyrites differ much from thofe of ores. Thus, although fometimes pyrites contains more metal than fome ores, yet generally it contains lefs metal, and a larger quantity of mineralizing fubftances, fulphur and arfenic, and particularly of unmetallic earth. The connection of thefe matters is alfo much ftronger in pyrites than in ores, and they are accordingly much harder; fo that almoft every pyrites can ftrike fparks from fteel.

From the above property of ftriking fparks from fteel they have been called *pyrites;* which is a Greek word fignifying *fire-ftone.* Pyrites was formerly ufed for firearms, as we now ufe flints; hence it was called *carabine-ftone.* It is ftill named by fome *marcafite.* Perhaps no other kind of natural body has received fo many names. Perfons curious to known the other names lefs ufed than thofe we have mentioned, may find them in *Henckel's Pyritologia.* We think, with that celebrated chemift, that the fubject has been perplexed by this multiplicity of names; for before his great and excellent work, the notions concerning pyrites were very confufed and inaccurate.

Pyrite differs alfo from ores by its forms and pofitions in the earth. Although pyritous metals generally precede, accompany, and follow veins of ores; they do not, properly fpeaking, themfelves form the oblong and continued maffes called *veins,* as ores do; but they form maffes fometimes greater and fometimes fmaller, but always diftinct from each other. Large quantities of them are often found unaccompanied by ores. They are formed in clays, chalk, marles, marbles, plafters, alabafters, flates, fpars, quartz, granites, cryftals, in a word, in all earths and ftones. Many of them are alfo found in pit-coals and other bituminous matters.

Pyrites is alfo diftinguifhable from ores by its luftre and figure; which is almoft always regular and uniform, externally or internally, or both. Some ores indeed, like thofe of lead, many ores of filver, and fome others, have regular forms, and are in fome manner cryftallized; but this regularity of form is not fo univerfal and fo confpicuous in ores as in pyrites. The luftre of pyrites feems to be caufed by its hardnefs, and the regularity of its form by the quantity of mineralizing fubftances which it contains.

By all thefe marks we may eafily, and without analyfis, diftinguifh pyrites from true ores. When we fee a mineral that is heavy, poffeffed of metallic luftre, and of any regular form, the mafs of which appears evidently to be entire, that is, not to have been a fragment of another mafs, and which is fo hard as to be capable of ftriking fparks from fteel, we may be affured that fuch a mineral is a pyrites, and not an ore.

The clafs of pyrites is very numerous, various, and extenfive. They differ one from another in the nature and proportions of their component parts, in their forms, and in their colours. The forms of thefe minerals are exceedingly various. No folid, regular or irregular, can eafily be conceived, that is not perfectly imitated by fome kind of pyrites. They are fpherical, oval, cylindrical, pyramidal, prifmatical, cubic; they are folids with 5, 6, 7, 8, 9, 10, &c. fides. The furface of fome is angular, and confifts of many bafes of fmall pyramids; while their fubftance is compofed of thefe pyramids, the points of which all unite in the centre of the mafs.

Pyritous minerals differ alfo in their component fubftances. Some of them are called *fulphureous, martial, cupreous, arfenical,* as one or other of thefe fubftances predominate. We muft obferve with Henckel, whofe authority is very great in this fubject, that in general all pyrites are martial; as ferruginous earth is the effential and fundamental part of every pyrites. This earth is united with an unmetallic earth, with fulphur or arfenic, or with both thefe matters; in which cafe, the fulphur always predominates over the arfenic, as Henckel obferves. He confiders thefe as the only effential principles of pyrites; and believes that all the other matters, metallic or unmetallic, which are found in it, are only accidental; amongft which he even includes copper, although fo much of it exifts in fome kinds of pyrites, that thefe are treated as ores of copper, and fometimes contain even 50lb. of copper each quintal. Many other metals, even gold and filver, are fometimes combined in pyrites; but thefe are lefs frequent, and the precious metals always in very fmall quantities; they are therefore juftly to be confidered as accidental to pyrites. The different fubftances compofing pyrites fenfibly affect its colours. Henckel diftinguifhes them in general into three colours, white, yellowifh or a pale yellow, and yellow. He informs us, that thefe three colours are often fo blended one with another, that they cannot be eafily diftinguifhed unlefs when compared together.

The white pyrites contain moft arfenic, and are fimilar to cobalt and other minerals abounding in arfenic. The Germans call them *mifpickel* or *mifpilt.* Iron and

and arſenic form the greateſt part of this pyrites. As arſenic has the property of whitening copper; ſome pyritous minerals almoſt white, like that of Chemnitz in Miſnia, are found to contain 40 pounds of copper per quintal, and which are ſo much whitened by the arſenic, that they are very like white pyrites. But Henckel obſerves, that theſe pyritous matters are very rare, and are never ſo white as the true white pyrites, which is only ferruginous and arſenical.

Yellowiſh pyrites is chiefly compoſed of ſulphur and iron. Very little copper and arſenic are mixed with any pyrites of this colour, and moſt of them contain none of theſe two metallic ſubſtances. This is the moſt common kind of pyrites: it is to be found almoſt every where. Its forms are chiefly round, ſpherical, oval, flattened, cylindrical; and it is compoſed internally of needles or radii, which unite in the centre, or in the axis of the ſolid.

Yellow pyrites receives its colour from the copper and ſulphur which enter into its compoſition. Its colour, however, is inclined to a green; but is ſufficiently yellow to diſtinguiſh it from the other two kinds of pyrites, particularly when they are compared together. To make this compariſon well, the pyrites muſt be broken, and the internal ſurfaces muſt be placed near each other. The reaſon of this precaution is, that the colour of minerals is altered by expoſure to the air.

Perſons accuſtomed to theſe minerals can eaſily diſtinguiſh them. The chief difficulty is, to diſtinguiſh white pyrites from cobalt and other minerals; which alſo contain ſome copper and much arſenic.

Hence then we ſee, that arſenic is the cauſe of whiteneſs in pyrites, and is contained in every pyrites of that colour; that copper is the principal cauſe of the yellow colour of pyrites; and that every pyrites which is evidently yellow contains copper; that ſulphur and iron produce a pale-yellow colour, which is alſo produced by copper and arſenic; hence ſome difficulty may ariſe in diſtinguiſhing pyrites by its colours. We may alſo obſerve, that ſulphur and arſenic, without any other ſubſtance, form a yellow compound, as we ſee from the example of orpiment or yellow arſenic. Thus, although the colours of the pyrites enable us to diſtinguiſh its different kinds, and to know their nature at firſt ſight, particularly when we have been accuſtomed to obſerve them; yet we cannot be entirely certain concerning the true nature of theſe minerals, and even of all minerals in general; that is, to know preciſely the kinds and proportions of their component ſubſtances, but by chemical analyſis and decompoſition.

Beſides the above-mentioned matters which compoſe pyrites, it alſo contains a conſiderable quantity of unmetallic earth; that is, an earth which cannot by any proceſs be reduced to metal. Henckel, Cramer, and all thoſe who have examined this matter, mention this earth, and prove its exiſtence.

We ought to obſerve, that this earth is combined with the other principles of the pyrites, and not merely interpoſed betwixt its parts. It muſt therefore be diſtinguiſhed from other earthy and ſtony matters mixed accidentally with pyrites, and which do not make a part of the pyrites, ſince they may be ſeparated by mechanical means, and without decompoſing that mineral: but the earth of which we now treat is intimately united with the other conſtituent parts of the pyrites, is even a conſtituent part of pyrites, and eſſential to the exiſtence of this mineral, and cannot be ſeparated but by a total decompoſition of it.

According to Henckel, this unmetallic earth abounds much in the white pyrites, ſince he found from the analyſes which he made, that the iron, which is the only metal exiſting in theſe pyrites, is only about $\frac{1}{16}$th part of the fixed ſubſtance that remains after the arſenic has been expelled by torrefaction or ſublimation.

A much larger quantity of iron is in the pale-yellow pyrites, according to Henckel. The proportion of iron is generally about twelve pounds to a quintal of pyrites, and ſometimes 50 or 60 pounds: this is therefore called *martial pyrites*. It contains about $\frac{1}{4}$ of its weight of ſulphur, and the reſt is unmetallic earth.

The quantity of unmetallic earth contained in the yellow or cupreous pyrites, which are alſo martial, ſince, as we have obſerved, iron is an eſſential part of every pyrites, has not yet been determined. They probably contain ſome of that earth, tho' perhaps leſs of it than the others.

The nature of this unmetallic earth of pyrites has not been well examined. Henckel thinks that it is an earth diſpoſed already by nature to metallization, but not ſufficiently elaborated to be conſidered as a metallic earth. This opinion is not improbable; but as alum may be obtained from many pyrites, may we not ſuſpect that this unmetallic earth is of the nature of the baſis of alum or argillaceous earth? Perhaps alſo this earth is different in different kinds of pyrites. The ſubject deſerves to be well examined.

Although pyrites is not ſo valuable as true ores, becauſe in general it contains leſs metal, and but exceedingly little of the precious metals; and becauſe its metallic contents are ſo difficult to be extracted, that, excepting cupreous pyrites, which is called *pyritous copper ore*, it is not worked for the ſake of the contained metal; yet it is applied to other purpoſes, and furniſhes us with many uſeful ſubſtances; for from it we obtain all our green and blue vitriols, much ſulphur, arſenic, and orpiment. *See the principal proceſſes by which theſe ſubſtances are extracted from pyrites, under the* ſection SMELTING *of* ORES.

As all pyrites contain iron, and moſt of them contain alſo ſulphur; as the pyrite moſt frequently found contains only theſe two ſubſtances with the unmetallic earth; and as iron and ſulphur have a ſingular action upon each other when they are well mixed together and moiſtened; hence many kinds of pyrites, particularly thoſe which contain only the principles now mentioned, ſuſtain a ſingular alteration, and even a total decompoſition, when expoſed during a certain time to the combined action of air and water. The moiſture gradually penetrates them, divides and attenuates their parts; the acid of the ſulphur particularly attacks the martial earth, and alſo the unmetallic earth, its inflammable principle is ſeparated from it, and is diſſipated. While theſe alterations happen, the pyrites changes its nature. The acid of the ſulphur which is decompoſed, forms with the fixed principles of the pyrites, vitriolic, aluminous, and ſelenitic ſalts; ſo that a pyrites, which was once a ſhining, compact, very hard mineral, becomes in a certain time a greyiſh, ſaline,

line, powdery mafs, the tafte of which is faline, auftere, and ftyptic.

Laftly, if this mafs be lixiviated with water, cryftals of vitriol, and fometimes of alum, according to the nature of the pyrites employed, may be obtained by evaporation and cryftallization.

This alteration and fpontaneous decompofition of pyrites, is called *efflorefcence* and *vitriolization;* becaufe the pyrites become covered with a faline powder, and becaufe vitriol is always formed. This vitriolization is more or lefs quickly accomplifhed in pyrites according to its nature. It is a kind of fermentation excited by moifture amongft the conftituent parts of thefe minerals; and it is fo violent in thofe which are moft difpofed to it, that is, in the pale-yellow pyrites, which contain chiefly fulphur and iron, that when the quantity of thefe is confiderable, not only a fulphureous vapour and heat may be perceived, but alfo the whole kindles and burns intenfely. The fame phenomena are obfervable, and the fame refults are formed, by mixing well together, and moiftening a large quantity of filings of iron and powdered fulphur; which experiment Lemeri has made, to explain the caufes of fubterranean fires and volcanos.

We cannot doubt that, as the earth contains very large maffes of pyrites of this kind, they muft undergo the fame changes when air and moifture penetrate the cavities containing them; and the beft natural philofophers agree, that very probably this furprifing decompofition of pyrites is the caufe of fubterranean fires, of volcanos, and of mineral waters, vitriolic, aluminous, fulphureous, hot and cold.

No other pyrites is fubject to this fpontaneous decompofition when expofed to humid air, but that which is both martial and fulphureous; that is, the pale-yellow pyrites. The arfenical pyrites, or that which contains little or no fulphur, is not changed by expofure to air. This latter kind is harder, heavier, and more compact, than the former. The pyrites which is angular and regularly fhaped, is chiefly of this kind. Mr Wallerius, in his Mineralogy, propofes to diftinguifh this kind of pyrites by the name of *marcafite.* When cut, it may be polifhed fo well as to give a luftre almoft equal to that of diamonds, but without refracting or decompofing the light; for it is perfectly opake. It has been employed fome years paft in the manufacture of toys, as of buckles, necklaces, &c. and is called in commerce *marcafite.*

We cannot, however, concur with Mr Macquer, (from whom the above is taken), in thinking that there is fufficient reafon for confidering the minerals called *pyrites*, as a diftinct clafs of fubftances from ores. They have indeed no mark by which they can certainly and conftantly be diftinguifhed from thefe. The hardnefs or property of ftriking ignited fparks from fteel is not common to all the fubftances generally called *pyrites;* for we find fome of thefe enumerated by mineralogifts which have not that property. Wallerius even mentions a pyrites which contains no iron, altho' that metal is thought by Henckel to be effential to pyrites. The diftinction of pyrites from ores has been chiefly introduced by miners; becaufe the greateft part of the former minerals contain fo little metal, and fo much of the mineralizing fubftances, fulphur, or arfenic, that they are feldom fmelted. Neverthelefs, fome kinds of pyrites are found which contain fo much copper, that they are fmelted with great profit. Accordingly, fome later mineralogifts confider the cupreous yellow pyrites as an ore of copper, the pale-yellow martial pyrites as an ore of iron; and the white arfenical pyrites as an ore of arfenic. See Ores *of* Copper, Iron, and of Arsenic, *infra.*

Sect. IV. *Effaying of Ores in general.*

Essays are chemical operations made in fmall, to determine the quantity of metal or other matter which is contained in minerals; or to difcover the value or purity of any mafs of gold or filver. The former kind is the fubject of the prefent fection; the latter is treated under the word Essays, in the order of the alphabet.

Before effays of ores can be well made, a preliminary knowledge of the nature of the feveral metallic minerals ought to be attained. Each metal has its proper and improper ores, which have peculiar characters and appearances: hence perfons accuftomed to fee them, know pretty nearly, by the appearance, weight, and other obvious qualities, what metal is contained in a mineral. A good effayer ought to be very intelligent in this matter, that he may at once know what the proper operations are which are requifite to the effay of any given mineral.

As metals are very unequally diftributed in their ores, we fhould be apt to make falfe and deceitful effays, if we did not ufe all poffible precautions that the proportionable quantity of metal produced by an effay fhall be nearly the medium contained in the whole ore. This is effected by taking pieces of the mineral from the feveral veins of the mine if there be feveral, or from different places of the fame vein. All thefe minerals are to be fhook together with their matrixes. The whole is to be well mixed together, and a convenient quantity of this mixture is to be taken for the effay. This is called the *lotting* of the ore.

As effays, particularly the firft, are generally made in fmall, effayers have very fmall weights correfponding to the weights ufed in the great; that is, to the quintal or hundred pounds weight, to pounds, ounces, drams, &c. The effay quintal and its fubdivifions, vary according to the difference of weights in different countries; and this occafions fome confufion, when thefe weights are to be adjufted to each other. Tables of thefe weights are found in treatifes of effaying; and particularly in that written by Schlutter, and tranflated and rendered more complete by Hellot, which contains all the details neceffary for the fubject.

The cuftom is to take, for the effay quintal, a real weight of a gros, or dram, which in France is equal to 72 grains; but as the whole dram reprefents 100 pounds, each grain reprefents a pound and a fraction of a pound; and hence fome difficulty and confufion arife in making the fubdivifions. A better method is that of Mr Hellot, which is to make the fictitious or effay quintal equal to 100 real grains, and then each grain reprefents a real pound. This effay quintal is fufficiently exact for ores of lead, tin, copper, iron, antimony, bifmuth, and mercury. But for ores of filver and gold, another reprefentation is convenient: for thefe metals, as Mr Hellot fays, are generally in fo fmall quantity, that the button or fmall piece of metal ob

obtained in the essay could not be accurately weighed if 100 real grains were made to represent a quintal; and the difficulty of separating the gold from so small a quantity would be still greater. These motives have induced Mr Hellot to use for these ores a fictitious quintal 16 times bigger; that is, equal to 1600 real grains, which represent 1600 ounces; that is, 100lb. or quintal. The ounce being represented by a grain, its several subdivisions must be represented by fractions of a grain. Thus 12 grains of the fictitious quintal correspond with $\frac{5}{48}$ of a real grain (B); and this latter quantity may be accurately weighed in essay-balances, which when well made are sensible to a much less weight. See *(Essay)* BALANCE.

When a quintal of an ore to be essayed has been weighed, and lotted, as we described above, it is to be roasted in a test under a muffle. It is to be washed, if necessary; and, in short, the same operations are to be made in small which are usually done in great. Additions also are to be made, and in proper proportions, according to the peculiar nature of the ore. The fluxes generally mixed with the ore in essays are three, four, or five parts of black flux; one, two, or three parts of calcined borax; and one half of that quantity of decrepitated common salt. The more refractory the ore is, the more necessary is the addition of these fluxes: then the whole mixture is to be fused either in a forge, or in a melting or essay furnace.

To make essays well, all possible attention and accuracy are to be employed. This object cannot be too much attended to; for the least inaccuracy in weighing, or loss of the smallest quantity of matter, might cause errors, so much greater, as the disproportion betwixt the weights employed and those represented is greater. The most minute accuracy therefore is necessary in these operations. For instance, the essay-balances ought to be small, and exceedingly just. The ore ought not to be weighed till it has been reduced to gross powder fit for roasting; because some of it is always lost in this pulverization. When the ore is roasted, it ought to be covered with an inverted test; because most ores are apt to crackle and disperse when first heated. To make the fusion good and complete, the precise degree of fire which is requisite ought to be employed; and when it is finished, the crucible ought to be struck two or three times with some instrument, to facilitate the disengagement of the parts of the regulus from the scoria, and to occasion their descent and union into one button of metal. The crucible ought not to be broken, nor its contents examined, till it is perfectly cold.

Upon breaking the crucible, we may know that the fusion has been good, if the scoria be neat, compact, and equal; if it has not overflowed or penetrated the crucible; if it contain no metallic grains; and if its surface be smooth, and hollowed in the middle. The regulus or button ought to be well collected, without holes or bubbles, and to have a neat convex surface; it is then to be separated from the scoria, well scraped and cleaned; and, lastly, is to be weighed. If the operation has been well made, its weight shews the quantity of metal which every real quintal of ore will yield in the great. If the perfect success of this essay be in any respect doubtful, it ought to be repeated; but the best method at all times is, to make several essays of the same ore. Some small differences are always found, however well the essays may have been made. By taking the medium of the results of the several operations, we may approach as nearly as possible the true product of the ore.

Lastly, as mines are not worked, nor founderies established (which cannot be done without considerable expence), till the ore has been essayed, ten or twelve real pounds of the ore ought to be previously essayed; and essayers ought to be furnished with necessary furnaces and instruments for these larger essays.

In Part II. to the several articles of the ores of metals, we shall add the most approved methods of essaying these ores. We shall here only further observe in general, that the methods commonly practised for essaying ores of imperfect metals, and semimetals especially, are insufficient to procure the whole quantity of metal contained in ores, or even so much as is obtained in the smelting of large quantities of ores; and that therefore the result of essays is not be considered as the precise quantity contained in an ore, but generally only as an inaccurate approximation to that quantity. M. Gellert ascribes one cause of the want of success of these operations to the alkaline salts employed as fluxes to the ores, by which most metallic calxes are partially soluble, but more especially so when any of the sulphur of the ore remains; which, by uniting with these salts, forms a hepar of sulphur which is the most powerful of all solvents. He proposes therefore to omit the black flux, and other alkaline salts, and to add nothing to the ore but powder of charcoal, and some fusible glass. This method, he says, he learned from Mr Cramer, and has himself used with much success in the essays of iron and copper: but finding that other imperfect metallic substances could not sustain the heat necessary to effect the fusion and vitrification of the unmetallic parts of the ore without being partly dissipated, he found it necessary to add in the essays of these latter metallic matters some borax, by which the fusion might be completed with less heat. As we consider this as a considerable improvement in the art of essaying ores, we shall, to the articles of the several ores, add not only the processes commonly prescribed, but all those of Mr Gellert, according to the method here mentioned.

PART

(B) The pounds, of which 100 is here supposed to make a quintal, are called *Paris pounds*, one of which contains 1269 Troy grains.

PART II.

Containing a summary description of the principal Ores of each Metal, and the methods of Effaying them.

Sect. I. *Ores of Gold.*

§ 1. PRoperly fpeaking, no ores of gold exift: for as this metal cannot be allayed with arfenic, nor with fulphur, it is never found directly mineralifed by thefe fubftances, as the other metals are. In the fecond place, if it be mineralifed indirectly by the union it contracts with other metals naturally combined with fulphur and arfenic, fo fmall a quantity of it only is found in thefe ores, that they fcarcely even deferve the name of *improper ores of gold.*

Hence gold is found either in its natural ftate, of a certain degree of purity, poffeffed of all its properties; or engaged with fome other metals in certain minerals.

The gold which is found alone is called *native* or *virgin gold.* This is generally incrufted, and fixed in different kinds of ftones, principally in flints and quartz. Mr Cramer fays, that the yellow brilliant fpots of the blue ftone, called *lapis lazuli*, are native gold; but thefe are very fmall.

Gold is alfo found in fat and muddy earths; and Mr Cramer affirms, that fcarcely any fand can be found which does not contain gold; but he acknowledges, at the fame time, that the quantity is too fmall to compenfate for the expence of obtaining it.

Laftly, the largeft quantity of native gold is to be found in the fands of fome rivers. It is chiefly collected in hollows at the bottom of thefe rivers, and at their feveral bendings. The gold is collected in thefe places by a natural operation, fimilar to that of wafhing of ores.

A confiderable quantity of gold is in the fand of feveral rivers in France: fo that perfons who collect it find enough to compenfate their trouble. Mr Reaumur, in a memoir that he gave in the year 1718 concerning the rivers of France which contain gold, enumerates ten of them; namely, the Rhine, the Rhone, the Doux, the Ceze, and the Gardon; the Arriege; the Garonne; two ftreams which flow into the Arriege, called *Ferriet* and *Benagues*; laftly, the Salat, the fource of which is in the Pyrenean mountains.

The Ceze is the river which furnifhes the largeft quantity of gold at certain times. Mr Reaumur obferves, that its particles are larger than thofe of the Rhine and of the Rhone; and fays, that in fome days a peafant will find gold to the value of a piftole, and in others will fcarcely find any.

The native gold found in rivers or elfewhere is never perfectly pure, or of twenty-four karats. It always contains a certain quantity of allay, which is generally filver. The gold of the French rivers, according to Mr Reaumur's trials, was found to be from eighteen to twenty-two karats, that of the Ceze being the loweft, and that of the Arriege being the pureft.

Although gold, however, as above obferved from Macquer, cannot be directly diffolved by fulphur, yet it probably may be mineralifed by the intervention of other metallic matters. Thus, although no proper ore of gold exifts, yet it is found in feveral mineral fubftances, in which it is always accompanied, as Cramer affirms, with a much larger quantity of filver; to which latter metal that author attributes its mineralifed ftate. The minerals containing gold are blend, cupreous and arfenical pyrites, ore of antimony, cinnabar, white ore of arfenic, vitreous and other filver ores, and the lead-ore called *galena*,

Gold is more frequently imbedded in quartz than in any other matrix, but it is alfo found in limeftone and in hornblend. Gold mines are in general very precarious, as they do not form regular veins, nor is the gold uniformly diftributed through a matrix.

Becher and Cramer think, that no fand is entirely free from gold. The yellow, red, black, and violet-coloured ferruginous fands, are faid to contain moft gold. Mr Hellot relates, that in a eleven effays of one kind of fand, from a quintal, or 921,600 grains, were obtained each time from 848 to 844 grains of noble metal, exclufive of the gold which remained in the fcoria; and that of the metal thus obtained two thirds were gold, and the remaining third was filver. He fays, that parcels of fand taken up at very fmall diftances from each other contained very unequal proportions of gold.

The gold found in fands is generally lefs pure than that which is imbedded in a folid matrix. Reaumur fays, that a piece of gold, weighting 448 ounces, was fhewn to the Royal Academy at Paris, which was found upon effay to have different finenefs in different parts of the mafs.

§ 2. *Ores and earths containing gold may be effayed* by the methods directed for the extraction of gold from large quantities of thefe auriferous matters, (fee Part III.): or they may in general be effayed by being fufed in a cupel or teft, placed under the muffle of an effay-furnace, or in a crucible placed in an air-furnace, with eight or ten times their quantity of lead if they be eafily fufible, and with a larger quantity of lead if they be difficultly fufible; and by fcorifying the earthy matters, while the lead becomes impregnated with the noble metals. Thefe operations are entirely fimilar to thofe employed for the feparation of filver from its ores by precipitation with lead; *a detail of which fee fubjoined under the fection* Ores *of* Silver, [*Proceffes* I. III. IV. V. VI.]. Thefe metals are afterwards to be feparated from the lead by cupellation, in the manner directed in the article Essay (*of the value of filver and of gold*). The gold is then to be feparated from the filver by the proceffes defcribed in the article Parting.

The quantity of lead to be added to the ore in this effay muft be fuch as renders the fcoria very thin, that the whole gold may be imbibed by the lead. Some iron ores containing gold cannot be reduced into

Platina and Silver.

into a ſcoria ſufficiently thin with ſixteen times their quantity of lead unleſs the heat be at the ſame time conſiderably increaſed. When the ore is exceedingly refractory, the ſcoriſication ought to be promoted by adding to it four times its quantity of tartar, twice its quantity of nitre, and four times its quantity of litharge. This mixture is to be put in a good eſſay-crucible, and covered with the ſea-ſalt. The crucible is to be ſet in a forge-hearth, and expoſed gradually to heat, till the ſcoria has acquired ſufficient fluidity, and the lead has imbibed the noble metal.

See the methods which have been uſed for eſſaying auriferous ſands, under Part III.

Sect. II. *Ores of Platina.*

Platina is very rare, and has been but lately diſcovered. As, like gold, it cannot be allayed with ſulphur or with arſenic, probably no *ore*, properly ſo called, exiſts of this metal. Accordingly in the only mines of platina which we know, namely, the gold mines of Santafe near Carthagena, the platina is found native like the gold, and in its metallic ſtate.

Sect. III. *Ores of Silver.*

§ 1. Next to gold, ſilver is the metal moſt frequently found in its metallic ſtate, that is, not mineraliſed by ſulphur or by arſenic. This ſilver, called alſo *native* or *virgin*, generally affects ſome regular form, and conſiſts of filaments or vegetations of various figures. It is found in form of plates, of fibres, or of grains, or cryſtallized. It lies generally in quartz, flint, ſpar, ſlate, cobalt, and in ſilver-ores. It is ſometimes enveloped in a thin ſtony cruſt. It is generally allayed with ſome gold: but ſilver, like all the other metals, is much more frequently found mineraliſed by ſulphur and by arſenic.

Three principal proper ores of ſilver are known, which are very rich, but very rare. Theſe are;

1. The *vitreous ſilver ore*. This ore has no determinate figure, and has nearly the colour, ſoftneſs, and fuſibility of lead. It is very heavy, and contains three quarters of its weight of pure ſilver. In this ore the ſilver is minerallized by ſulphur alone. Some expert artiſts imitate it very well by combining ſulphur with ſilver by fuſion in a crucible.

This ore, according to Cronſtedt, is either in form of plates or of fibres, or is cryſtallized, or has no determinate figure. It may be imitated by adding about five parts of ſulphur to one part of melted ſilver; in which operation moſt of the ſulphur is conſumed: or it may be imitated by expoſing a plate of ſilver red-hot to the fumes of burning ſulphur.

2. The *horny* or *corneous ſilver ore*. This ore is ſo called from its colour and ſemitranſparency, by which it reſembles horn or colophony. This ore, being ſuddenly heated, crackles, as almoſt all ores do, and melts with a gentle heat. Two-thirds of it are ſilver, which is mineraliſed by ſulphur and arſenic. This ore is very rare. Wallerius ſays, after Woodward, that it is found at Johaun-Georgen-Stadt in Saxony.

Corneous ore has various colours; white, pearly, brown, yellow, greeniſh, or reddiſh. It is foliated and ſemitranſparent. It is ſomewhat ductile, and fuſible with the flame of a candle. When heated, it emits, as Wallerius ſays, a ſulphureous and blue flame, and, according to Cramer, alſo a very ſmall quantity of an arſenical fume. Wallerius ſays, that it contains two-thirds of ſilver, with a conſiderable quantity of ſulphur, and a ſmall quantity of arſenic. Lehman thinks that it is ſilver united with a little arſenic. But Mr Cronſtedt ſays, that it is a luna cornea, or ſilver combined with marine acid; and that it is incapable of being decompoſed but by ſubſtances which can unite with that acid. This latter opinion ſeems to be the moſt probable; as the ore, according to its deſcription, is ſimilar to luna cornea, and as it cannot be imitated by any mixture of ſulphur and of arſenic with ſilver. The blue flame, and the ſmell ſlightly arſenical, which are emitted from heated corneous ore, are alſo obſervable from every combination of marine acid with a ſubſtance containing phlogiſton.

Ores of Silver.

3. *Red ſilver ore*, called alſo *roſiclare*. Its colour is more or leſs red; it is ſometimes cryſtallized, very heavy, and is fuſible like the above-mentioned ores. In this ore the ſilver is mineraliſed by arſenic and by ſulphur, but chiefly by the former. It alſo contains a little iron, and furniſhes two-thirds of its weight of ſilver. Its red colour may proceed either from the iron it contains; or from the mixture of arſenic and ſulphur; or, laſtly, from the particular manner in which the arſenic is united with the ſilver, an example of which we have in the red precipitate of ſilver made by the neutral arſenical ſalt.

Red ſilver ore is either plated or ſolid, or cryſtallized, and frequently ſemitranſparent. Its colour is various, from a dark grey to a deep red, according to the proportions of the two mineraliſing ſubſtances. It crackles and breaks in the fire, exhales an arſenical fume, and is readily fuſed. It is found generally in quartz, ſpar, cryſtal, hornblend.

Beſides the three ſilver ores above deſcribed, the following ores contain ſilver mixed with other metals.

1. *Grey ſilver ore*. This contains copper and ſilver mineraliſed by arſenic and ſulphur, and generally more of the former than of the latter metal; but as it is valued chiefly for the ſilver, it has been generally enumerated amongſt ſilver ores.

2. *White ſilver ore* is an arſenical pyrites containing ſilver.

3. *Black ſilver ore* contains ſulphur, arſenic, copper, iron, ſometimes lead, and about a fourth part of ſilver, according to Wallerius.

4. *Plumoſe ſilver ore* is white or black, ſtriated like plum-alum, or like ore of antimony. It is ſilver mineraliſed by ſulphur, arſenic, and antimony.

5. *Pech-blend*. In this blend ſilver, gold, and zinc, are mineraliſed by ſulphur, probably by intervention of iron, by which the gold and zinc are rendered capable of uniting with the ſulphur.

6. Silver is frequently found in *galena;* and ſometimes in *martial pyrites;* in the *red ore of arſenic;* in various *ores of copper, lead, tin, iron*, and eſpecially *cobalt;* in *blends;* in *yellow* or *red earths;* in *black* and *blue baſaltes;* and alſo in *ſtrata of ſtones* which do not appear externally to contain any mineral ſubſtance.

7. *Liquid ſilver ore*, or *guhr of ſilver*, is a grey or whitiſh liquid maſs, which contains, as Wallerius ſays, either native ſilver, or ſome fluid ſubſtance capable of producing it. Mr Cronſtedt mentions, in the Swediſh

Essaying of Ores of Silver.

dish Memoirs, a water flowing through a mine in Norway containing silver. Another instance is also mentioned of a silver guhr, in the *Act. Erud. Upsal.* 1720.

8. Mr Von Justi pretends, that he has found silver mineralised by an *alkaline substance;* but he has not spoken sufficiently distinctly concerning it, to know whether he means a saline or earthy alkaline matter. Henckel also pretends, that by treating calcareous earth or certain clays with pyrites, silver may be obtained.

§ 2. *Ores of silver may be essayed* by the same methods which are employed for the extraction of that metal from large quantites of ores; which methods are different, and suited to the different qualities of the different ores. See Part III. Or, in general, ores and earths containing silver may be essayed by the following processes, which are copied from Dr Mortimer's English edition of *Cramer's Art of Essaying Metals, Part II. Process* 1.

PROCESS I.

To precipitate Silver by means of Lead from fusible Ores.

"Pound the ore in a very clean iron mortar into fine powder: of this weigh one docimastical centner or quintal, and eight of the like centners of granulated lead.

"Then have at hand the docimastical test, which must not as yet have served to any operation: pour into it about half of the granulated lead, and spread it with your finger thro' the cavity of it.

"Put upon this lead the pounded ore; and then cover it quite with the remainder of the granulated lead.

"Put the test thus loaded under the muffle of an essay-furnace, and in the hinder part of it: then make your fire, and encrease it gradually. If you look thro' the holes of either of the sliders, you will soon see that the pounded ore will be raised out of the melted lead, and swim upon it. A little after, it will grow clammy, melt, and be thrown towards the border of the test: then the surface of the lead will appear in the middle of the test like a bright disc, and you will see it smoak and boil: so soon as you see this, it will be proper to diminish the fire a small matter for a quarter of an hour; so that the boiling of the lead may almost cease. Then again, increase the fire to such a degree, that all may turn into a thin fluid, and the lead may be seen, as before, smoking and boiling with great violence. The surface of it will then diminish by degrees, and be covered over with a mass of scorias. Finally, have at hand an iron hook ready heated, wherewith the whole mass must be stirred, especially towards the border; that in case any small parcels of the ore not yet dissolved should be adherent there, they may be brought down, taking great care not to stir any the least thing out of the test.

"Now, if what is adherent to the hook during the stirring, when you raise it above the test, melts quickly again, and the extremity of the hook grown cold is covered with a thin, smooth, shining crust; it is a sign that the scorification is perfect; and it will be the more so as the said crust adherent to the hook shall be coloured equally on every side: but in case, while the scorias are stirred, you perceive any considerable clamminess in them, and when they adhere in good quantity to the hook, though red-hot, and are inequally tinged, and seem dusty or rough with grains interspersed here and there; it is a sign that the ore is not entirely turned into scorias. In this case, you must with a hammer strike off what is adherent to the hook, pulverize it, and with a laddle put it again into the test, without any loss or mixture of any foreign body, and continue the fire in the same degree till the scoria has acquired its perfection and the abovementioned qualities. This once obtained, take the test with a pair of tongs out of the fire, and pour the lead, together with the scoria swimming upon it, into a cone made hot and rubbed with tallow. Thus will the first operation of the process be performed, which does not commonly indeed last above three quarters of an hour.

"With a hammer strike the scorias off from the regulus grown cold, and again examine whether they have the characteristics of a perfect scorification; if they have, you may thence conclude, that the silver has been precipitated out of the ore turned to scorias, and received by the lead.

"When the scorification lasts longer than we mentioned, the lead at last turns to scorias or litharge, and the silver remains at the bottom of the vessel: but the fire must be moderately supplied, and the vessels be extremely good, to produce this effect; for they seldom resist to the strength of the scorias long enough; so that the whole scorification may be brought to an end; which has afterwards this inconveniency, that the silver is dissipated by grains in the small hollows of the corroded ore, and can hardly be well collected again, when the ore has but little silver in it. Nay, there is still more time to be consumed to obtain the perfect destruction of the lead, by means of the combined actions of the fire and air, because the scorias swimming at the top retard it considerably.

"In this process, the sulphur and the arsenic of the silver-ore, when the ore is broken small, and extended widely in a small quantity, are in part easily dissipated by the fire, and in part absorbed by the lead; the lighter part of which, swimming upon the heavier, becomes very clammy by means of the sulphur which is in the ore; but when this is dissipated by the violence of fire, it turns into glass or scorias: but when arsenic is predominant in the ore, the plumbeous part turns immediately into a very penetrating and very fusible glass, having a dissolving efficacy, unless the arsenic lies hidden in a white pyrite or cobalt. For this reason, the fixed part of the ore, which is no silver, is dissolved by that glass, melts, and assumes the form of scorias. The unmetallic earths and the pure copper or lead ores thereto adherent are of this kind. The silver then remains immutable; and being freed of these heterogeneous bodies, which are partly dissipated and partly melted, it is precipitated and received by the remaining regulus of lead. Therefore this process is completed by three distinct operations; viz. 1. By roasting. 2. By scorification. 3. By the melting precipitation of the silver, which is the result of the two former operations.

"The

Effaying of Ores of Silver.

" The ore muft be pulverifed very fine, in order to increafe the furface, that the diffipation of the volatiles and the diffolution by litharge may be fooner effected. This pulverifing muft then be done before the ore is weighed, becaufe there is always fome part of the ore adherent to the mortar or iron plate on which it is made fine; which part being loft, the operation is not exact. Erker was in the right when he prefcribed eight centners of lead for the fubduing of fufible ores. Neverthelefs, it muft be owned, that this quantity is fuperfluous in fome cafes. However, as the fluxibility of the filver-ore depends from the abfence of ftones, pyrites, &c. it is eafy to fee, that there are an infinite number of degrees of fluxibility which it would be needlefs to determine exactly, and moft commonly very difficult to determine by the bare fight. Befides, a little more lead does not render the procefs imperfect; on the contrary, if you ufe too fmall a quantity of lead, the fcorification is never completely made. Nay, there are a great many ores, containing fulphur and arfenic in plenty, that deftroy a confiderable quantity of lead: fuch are the red filver-ore, and that wherein there is a great deal of the fteel-grained lead-ore. If the fire muft be fometimes diminifhed in the middle of the procefs, it is in order to hinder the too much attenuated litharge, which is continually generated out of the lead, from penetrating the pores of the teft, and from corroding it; which is eafily done when the fire is over-ftrong; for then the furface of the veffel which is contiguous to the lead contracts cavities, or, being totally confumed by fmall holes, lets the regulus flow out of it. The veffels that are moft fubject to this inconvenience are thofe in the materials of which lime, plafter, and chalk are mixed. Nay, thefe bodies, which are of their nature refractory, being eroded during their fcorification, at the fame time communicate a great clamminefs to the fcoria; fo that a great quantity of the mafs remains adherent to the teft in the form of protuberances, when you pour it out; whereby a great many grains of the regulus are detained."

PROCESS II.

The regulus obtained by the procefs I. contains all the filver of the ore, and the unfcorified part of the lead. The filver may be afterwards feparated from the lead, and obtained pure by *cupellation;* which procefs is defcribed under the article Essay *(of the value of Silver.)*

PROCESS III.

If the filver-ore cannot be wafhed clean, or if it be rendered refractory by a mixture of unmetallic earths and ftones, the fcorification of thefe earthy matters frequently cannot be completed by the procefs I. Cramer therefore directs, that fuch ores fhall be treated in the following manner.

" Bruife the ore into an impalpable powder, by grinding in a mortar; to a docimaftical centner of it, add a like quantity of glafs of lead finely pulverifed; for the more exactly thefe two are mixed together, the more eafily the fcorification afterwards fucceeds. Put this mixture, together with 12 centners of lead, into the teft, according to procefs I. then put the teft under the muffle.

" Make firft under it a ftrong fire, till the lead boils very well; when you fee it fo, diminifh the violence of the heat, as was directed in the firft procefs; but keep it thus diminifhed a little longer: then, finally, again increafe the fire to fuch a degree, till you perceive the figns of a perfect fcorification and fufion. *See the whole procefs I.* Now this procefs lafts a little longer than the foregoing, and requires a greater fire towards the end.

" It fometimes happens that a very refractory ore cannot be diffolved by litharge; and that a mafs, which has the clamminefs of pitch, fwims upon the regulus and upon the fcorias themfelves which are already fubdued in part: when you fee this, fhut the vents of the furnace to diminifh the fire; then gently touch this refractory body with a fmall iron cold hook, to which it will immediately ftick; take it off foftly, not to lofe any thing; pound it into a fine powder, adding a little glafs of lead, and put it again into the teft; then continue the fcorification till it is brought to its perfection. But you muft always examine the fcoria of your refractory ore, to fee whether there may not be fome grains of regulus difperfed in it: for fometimes the fcorias that grow clammy retain fomething of the metal; which if you fufpect, pound the fcorias into a fine duft, and thus the grains of metal will appear if there are any left, becaufe they can never be pounded fine. The filver is feparated from this regulus by cupelling, as in Procefs II.

" All earths and ftones are refractory in the fire: for, although fome of them melt naturally in the fire, as thofe that are vitrifiable do; neverthelefs, all the others, a very few excepted, melt much more difficultly than metals, and never become fo thin in the fufion as is required for the fufficient precipitation of a precious metal. But litharge itfelf does not conveniently diffolve thefe refractory matters by the help of fire alone, unlefs you add fome mechanical mixture to them; for the very moment the faid litharge penetrates through the interftices of the refractory ore, and begins to diffolve it, a tenacious mafs is produced, which hardly admits any farther dilution by the litharge. You may fee it plain, if you make coloured glaffes with metallic calxes; if you pour carelefly upon them a calx that gives a colour, you will never obtain that they may be equally dyed on every fide, even although you fhould torture them for whole days together in a great fire. Nay, glafs already made can never be diluted by only pouring falts and litharge upon it. Wherefore, you muft ufe the artifice of glafs-makers, who, in the making of the moft perfect glaffes, take great care, before they put the fpecies of their ingredients into the fire, to have a mechanical mixture precede, or at leaft accede during the fufion itfelf, which is done here by pounding glafs of lead mixed with the ore: but if you think that your glafs of lead is not fufficiently fufible, you may add to it litharge melted firft, and then pounded into a fine powder.

" As this fcorification requires a longer and a greater fire than the foregoing, and as a greater quantity of litharge is moreover requifite to fubdue the refractory fcoria; it is eafy to fee why a much greater quantity of lead muft be ufed here than in Procefs I.; and, although lefs lead is often fufficient, it

it is neverthelefs proper always to ufe the greateft quantity that can be neceffary; left, for inftance, it fhould be neceffary to try fo many times the lead alone, to make it evident how much filver the lead when alone leaves in the coppel. Nor need you fear left any thing of the filver be taken away by the lead, provided the coppels be good, and the coppelling duly put in execution: for you can hardly collect a ponderable quantity of filver out of the collected fume of the lead, which rifes during the coppelling, as well as out of the litharge that is withdrawn into the coppel."

PROCESS IV.

If the ore be rendered refractory by pyrites, Cramer directs that the filver fhould be precipitated by lead in the following manner. *(Art of Affaying*, Part II. proc. 4.)

" Break your ore into a rough powder, and put a centner of it into the teft: put upon this another teft in the manner of a tile; put it under the muffle hardly red-hot: increafe the fire by degrees. There will always be a crackling: which being ended, take away the upper-teft; for when the veffels have been red-hot about one minute, the ore ceafes to fplit. Leave the ore under the muffle till the arfenic and the fulphur are for the moft part evaporated; which you will know from the ceffation of the vifible fmoke, of the fmell of garlic, or the acid; then take away the teft, and leave it in a place not too cold, that it may cool of itfelf.

" Pour out, without any diffipation, the roafted ore, and with a knife take away what is adherent to the veffel; pound it to a moft fubtile powder, and grind it together with an equal weight of glafs of lead; and, finally, fcorify the whole collected ore in the fame teft wherein the tefting was made, unlefs it has contracted chinks, as was defcribed in Procefs III.

" *Remarks*. Yellow pyrites-ores contain a very great quantity of fulphur, even greater than is neceffary to faturate the metal that lies hidden in them. For which reafon this fuperfluous fulphur diffipates in a middling fire; but if it had been mixed with lead, it would have rendered it refractory, nor could it afterwards be diffipated from it without a confiderable deftruction of the lead. The white arfenical pyrites turn alfo a great quantity of lead into glafs, on account of the abundance of the arfenic they contain. For which reafon thefe ores muft be previoufly roafted, that the fulphur and arfenic may be diffipated. Nor need you fear left any part of the filver be carried away with the arfenic; for when arfenic is feparated from any fixed body, by a certain degree of fire, it carries nothing of that body away with it."

PROCESS V.

SILVER may be precipitated from its ore by cupellation only, in the following Procefs, given by Cramer, [*Art of Affaying, Part* II. *Proc.* 9.]

" Pound one centner of ore; roaft it in the manner directed in the laft procefs; beat it to a moft fubtle powder; and if it melts with difficulty on the fire, grind it together with one centner of litharge, which is not neceffary when the ore melts eafily: then divide the mixture or the powder of the ore alone into five or fix parts, and wrap up every one of them feverally in fuch bits of paper as can contain no more than this fmall portion.

" Put a very large coppel under the muffle; roaft it well firft, and then put into it fixteen centners of lead: when the lead begins to fmoke and boil, put upon it one of the faid portions with the fmall paper it was wrapt up in, and diminifh the fire immediately, in the fame manner as if you would make a fcorification in a teft, but in a leffer time. The fmall paper, which turns prefently to afhes, goes off of itfelf, and does not fenfibly increafe the mafs of the fcorias. The ore proceeding therefrom is caft on the border, and turns to fcorias very foon. Increafe the fire again immediately, and, at the fame time, put another portion of the ore into the coppel, as was juft now faid. The fame effects will be produced. Go on in the fame manner, till all the portions are thrown in and confumed in the lead. Finally, deftroy the remaining lead with a ftronger fire.

" The filver that was in the ore and in the lead will remain in the coppel. If you deduct from it the bead proceeding from the lead, you will have the weight of the filver contained in the ore. If the ore employed was eafy to be melted, all the fcoria vanifhes; but if it was refractory or not fufible, all the fcoria does not always go away, but there remains fomething of it now and then in the form of duft. A great many ores and metals may be tried in this way, except only fuch as fplit and corrode the coppels. There are likewife fome of them which muft be previoufly prepared in the fame manner as is required to render them fit for going through a fcorification. *See the foregoing Proceffes.*

" *Remarks*. The ore thrown at feveral times upon lead boiling in a coppel may be diffolved without the foregoing fcorification: but this is very far from having an equal fuccefs with all kinds of ores; for there are ores and metals which refift very much to their diffolution by litharge; and which being on this account thrown on the border, are not fufficiently diffolved; becaufe the litharge fteals away foon into the coppel. Neverthelefs, there are fome others which vanifh entirely by this method, except the filver and gold that was contained in them.

" A previous roafting is neceffary, firft, for the reafons mentioned, and then becaufe the ore thrown upon boiling lead fhould not crackle and leap out; for, having once paffed the fire, it bears the moft fudden heat."

PROCESS VI.

Silver may be precipitated out of the fame bodies as were mentioned in the foregoing proceffes by fcorification in a crucible. [*Cramer, Proc.* 15.]

" The body out of which you intend to precipitate filver muft be previoufly prepared for a fcorification by pounding and roafting, as mentioned in the former proceffes. Then, in the fame manner, and with the fame quantity of lead, put it into a crucible ftrictly examined, that it be entire, folid, not fpeckled with black fpots, like the fcoria of iron, efpecially at its inferior parts, and capable of containing three times as

Effaying of Ores of Silver.

as much. Add befides glafs gall and common falt, both very dry, and enough, that when the whole is melted, the falts may fwim at top at the height of about half an inch.

"Put the crucible thus loaded into a wind-furnace; fhut it clofe with a tile; put coals round it, but not higher than the upper border of the crucible. Then light them with burning coals, and increafe the fire till the whole melts very thin, which will be done by a middling fire, maintained always equal, and never greater: leave it thus for about one quarter of an hour, that the fcorification may be perfectly made. Take off the tile and ftir the mafs with an iron wire, and a little after pour it out into the mould. When the regulus is cleaned from fcorias, try it in a teft by coppelling it.

"*Remarks.* The fcorification of any ore whatever, or of any body fetched out of ores, may indeed be made by this apparatus, as well as in a teft under a muffle: but it ferves chiefly to the end that a greater quantity of metal may be melted from it with profit. For you may put many common pounds of it at one fingle time into the crucible; but then you need not obferve the proportion of lead prefcribed in the foregoing procefs; nay, a quantity of lead two or three times lefs is fufficient, according to the different qualities of the object. But the mafs will certainly be fpilt, unlefs you choofe a very good crucible; for there is no veffel charged with litharge, that can bear a ftrong fire having a draught of wind, without giving way through it to the litharge.

"You add glafs-gall and common falt, that they may forward the fcorification, by fwimming at top; for the refractory fcoria rejected by the litharge, and adhering between this and the falts that fwim at top, is foon brought to a flux, and the precipitation of the filver is thereby accelerated. They alfo hinder in a manner a fmall burning coal fallen into the crucible, from fetting the litharge a boiling, which troubles the operation; for the litharge or glafs of lead, efpecially that which is made without any addition, fo foon as the phlogifton gets into it, raifes into a foamy mafs, confifting of a multitude of fmall bubbles very difficult to be confined, unlefs the phlogifton be entirely confumed, and the litharge reduced to lead, which fometimes raifes above the border of the veffel."

Copper Ores.

Native metallic filver may be feparated from the ftones and earths with which it is intermixed, by *amalgamation with mercury*, which operation is to be performed in the fame manner as for the feparation of native gold; a detail of which fee in Part III. fect. iii.

The *corneous ore*, if it really be, as Cronftedt fays, a luna cornea, ought to be treated in fome of the methods directed for the reduction of luna cornea. See CHEMISTRY, n° 366, 367.

SECT. IV. *Ores of Copper.*

§ 1. COPPER is found under ground in three different forms. 1. Native or virgin copper diverfely ramified, which is much more rare than native filver. This native copper is not fo ductile as copper purified by fufions from the ore (A). 2. Copper is found in form of calx, of verdigreafe, of precipitates. Such are the minerals called *filky copper ores*, and feveral white and green earths. Thefe matters are only copper almoft pure and but little mineralifed, but which has been corroded, diffolved, precipitated, calcined by faline matters, by the action of the air, of water, and of earths (B). 3. Copper is frequently in a truly mineral ftate, that is, combined with fulphur, and with arfenic, with other metallic matters mixed with earths, and enveloped in different matrixes. Thefe are the true copper ores. They have no regular forms except they partake of the nature of pyrites. Their colours are very different, which depend chiefly on the proportion of the mineral fubftances compofing them. Laftly, in almoft all of them we may perceive green or blue colours, which always indicate an erofion or calcination of the copper. Moft copper ores contain alfo fome iron or ferruginous earth, to which the ochrey colour is to be attributed, which might make us believe them to be ores of iron. Ores which contain much iron are the moft difficultly fufible.

Copper ores have almoft all a yellow, golden, and fhining colour, by which they are eafily diftinguifhed. Some of them are coloured with irifes, and frequently have fpots of verdegrife, by which alfo they are diftinguifhable from other ores.

Many copper ores are alfo rich in filver. Such is that called the *white copper ore*, the colour of which is rather occafioned by arfenic than by filver, altho' it contains fo much filver as to be enumerated by feveral mine-

(A) *Native Copper* is folid; or confifting of friable maffes, formed by precipitation of cupreous vitriolic waters, called *cement* or *ziment copper*; or forming cryftallized cubes, or grains, leaves, branches, or filaments.

(B) *Calciform ores* are either pure calxes of copper, or are mixed with heterogeneous matters. 1. The *pure* are, loofe friable ochre, called *cæruleum montanum*, mountain-blue, and *viride montanum*, mountain-green; and the *red indurated calx*, called improperly *glafs copper ore*. 2. *Mixed* calciform ores are thofe in which the calx of copper is mixed; with *calcareous earth*, forming a mountain blue; with *iron*, forming a black calx; with *gypfum*, an indurated green ore, called *malachites*; and with *quartz*, a red ore.

(C) Copper is *mineralifed*, 1. By *fulphur*, forming the *grey copper ore*, improperly called *vitreous* (minera cupri vitrea Wallerii). 2. By *fulphurated iron*, forming the *hepatic copper ore* (minera cupri hepatica Wallerii) of a brown yellow colour. It is a kind of cupreous pyrites, and is called by Cronftedt *minera cupri pyritacea*. Sometimes it is of a blackifh grey colour, and is then called *pyrites cupri grifeus* (minera cupri grifea Wallerii); fometimes of a reddifh yellow, and tarnifhed with blue irifes on its furface, when it is called *minera cupri lazurea*; when of a yellowifh green colour, it is the *pyrites cupri flavo-viridefcens* (cuprum fulphure & ferro mineralifatum Wallerii); and when of a pale yellow colour, it is the *pyrites cupri palidè flavus*. Moft of the above pyritaceous ores contain alfo fome arfenic, but their fulphur is predominant. 3. *Copper mineralifed by fulphur, iron, and arfenic. White copper ore* (Minera cupri alba Wall.) This ore contains alfo fome filver. 4. *Copper diffolved by vitriolic acid. Native blue vitriol.* 5. *Copper united with bitumens. Copper-coal ore.* This is a pit-coal, from the afhes of which copper is obtainable. 6. Copper is alfo found in the mineral called *kupfer nickel*.

Essaying of Ores of Copper.

mineralogists amongst silver ores.

Lastly, the pyrites of a golden yellow colour which contains copper and sulphur, and the white pyrites which contains copper and arsenic, are considered as copper ores by several chemists and naturalists. Henckel and Cramer remark, that no proper ore of copper is known which does not contain a considerable quantity of arsenic.

§. 2. *Ores of copper* may be *essayed* in methods similar to those employed for smelting of large quantities of ores, (Part III.) or they may in general be essayed by the following processes.

PROCESS I.

To reduce and precipitate copper from a pure and fusible ore in a close vessel.

"Mix one, or, if you have small weights, two docimastical centners of ore beat extremely fine, with six centners of the black flux; and having put them into a crucible or pot, cover them one inch high with common salt, and press them down with your finger: but let the capacity of the vessel be such, that it may be only half full; shut the vessel close, put it into the furnace; heap coals upon it, so that it may be covered over with them a few inches high; govern the fire in such a manner, that it may first grow slightly red-hot. Soon after you will hear your common salt crackle; and then there will be a gentle hissing noise. So long as this lasts, keep the same degree of fire till it is quite over. Then increase suddenly the fire, either with the funnel and cover put upon the furnace, or with a pair of bellows applied to the hole of the bottom part, that the vessel may grow very red-hot. Thus you will reduce and precipitate your copper in about a quarter of an hour: then take out the vessel, and strike with a few blows the pavement upon which you put it, that all the small grains of copper may be collected in one mass.

"Break the vessel, when grown cold, in two, from top to bottom, as nearly as you can: if the whole process has been well performed, you will find a solid, perfectly yellow and malleable regulus adhering to the bottom of the vessel, with scorias remaining at top of a brown colour, solid, hard, and shining, from which the regulus must be separated with several gentle blows of a hammer; this done, weigh it, after having wiped off all the filthiness.

A soft, dusty, and very black, scoria, is a sign of a fire not sufficiently strong. Small neat grains of copper reduced but not precipitated, and adhering still to scorias, especially not very far from the bottom, and an unequal and ramificated regulus, are signs of the same thing. A solid, hard, shining, red-coloured scoria, especially about the regulus, or even the regulus itself when covered with a like small crust, are signs of an excess in the degree and duration of the fire.

"*Remarks.* All the ores which are easily melted in the fire are not the objects of this process; for they must also be very pure. Such are the vitreous copper ores." (Mr Cramer means, it is presumed, the red calciform ore called improperly *glass ore*, and not the *minera cupri vitrea* of Wallerius, which being composed of copper mineralised by sulphur, could not be treated properly by this process, in which no previous roasting is required. The sulphur of this ore would with the alkali of the black flux form a hepar, from which the metal would not precipitate.) "But especially the green and azure-coloured ores, and the *cæruleum* and *viride montanum*, which are not very different from them. But if there is a great quantity of arsenic, sulphur, or of the ore of another metal and semimetal joined to the ore of copper, then you will never obtain a malleable regulus of pure copper, tho' ores are not always rendered refractory by the presence of these."

PROCESS II.

To reduce and precipitate copper out of ores rendered refractory by earth and stones that cannot be washed off.

"Beat your ore into a most subtil powder, of which weigh one or two centners, and mix as much sandiver to them. This done, add four times as much of the black flux with respect to the ore; for by this means, the sterile terrestrial parts are better disposed to a scorification, and the reducing and precipitating flux may act more freely upon the metallic particles freed from all their incumbrances.

"As for the rest, make the apparatus as in last process: but you must make the fire a little stronger for about half an hour together. When the vessel is grown cold and broken, examine the scorias, whether they are as they ought to be. The regulus will be as fine and ductile as the foregoing.

"*Remarks.* As these copper ores hardly conceal any sulphur and arsenic in them, the roasting would be of no effect, and much copper would be lost. For no metallic calx, except those of gold and silver, improperly so called, can be roasted, without you find a part of the metal lost after the reduction.

PROCESS III.

To precipitate copper out of an ore (D) *that contains iron.*

"Do all according to last process. But you will find, after the vessel is broken, a regulus upon no account so fine, but less ductile, wherein the genuine colour of the copper does not perfectly appear, and which must be further purified.

"*Remarks.* The fire used in this operation is not so strong that the iron should turn to a regulus. But as copper is the menstruum of iron, which is of itself very refractory in the fire; for this reason, while the ore and the flux are most intimately mixed and confounded by trituration, the greatest part of the iron being dissolved by the copper, turns into a regulus along with it."

PROCESS IV.

The roasting of a pyritose, sulphureous, arsenical, semimetallic, copper ore.

"Break two docimastical centners of the ore to a coarse powder, put them into a test covered with a tile,

(D) Mr Cramer still means the calciform ores only, and not the mineralised ores of copper.

tile, and place them under the muffle of a docimaftical furnace. But the fire muft be fo gentle, that the muffle may be but faintly red-hot. When the ore has decrepitated, open the teft, and continue the fire for a few minutes; then increafe it by degrees, that you may fee the ore perpetually fmoking a little: in the mean time, it is alfo proper now and then to ftir it up with an iron hook. The fhining particles will affume a dark red or blackifh colour. This done, take out the teft, that it may grow cold. If the fmall grains are not melted, nor ftrongly adherent to each other, hitherto all will be well; but if they run again into one fingle cake, the procefs muft be made again with another portion of the ore, in a more gentle fire.

"When the ore is grown cold, beat it to a powder fomewhat finer, and roaft it by the fame method as before; then take it out, and if the powder is not melted yet, beat it again to a moft fubtil powder; in this you are to take care that nothing be loft.

"Roaft the powder in a fire fomewhat ftronger, but for a few minutes only. If you do not then find the ore any way inclined to melt, add a little tallow, and burn it away under the muffle, and do the fame another time again, till, the fire being very bright, you no longer perceive any fulphureous, arfenical, unpleafant fmell, or any fmoke; and there remains nothing but a thin, foft powder, of a dark red, or blackifh colour.

"*Remarks.* Every pyrites contains iron, with an unmetallic earth: to which fulphur, or arfenic, and moft commonly both, always join. Befides, there is copper in many pyrites; but fometimes more, and fometimes lefs: fome of them are altogether deftitute of copper; therefore, fo much as pyrites differ with regard to the proportion of their conftituent particles, fo much do they differ as to their difpofition in the fire. For inftance, the more copper there is in pyrites, the more it inclines to colliquation. The more fulphur and arfenic it has in it, the more quickly the melting of it will be procured, and the reverfe: the more iron and unmetallic earth it contains, the more it proves refractory in the fire. Now if fuch pyrites melt in the roafting, as happens to fome of them if they grow but red-hot, the fulphur and arfenic that lies hidden therein are fo ftrictly united with the fixed part, that you would in vain attempt to diffipate them. Nay, in this cafe, when it is reduced again into a powder, it requires a much greater time and accuracy in the regimen of the fire to perform the operation. For this reafon, it is much better to repeat it with new pyrites. But you can roaft no more than the double quantity at once of the ore you have a mind to employ in the foregoing experiment; to the end that, the precipitation by fufion not fucceeding, there may remain ftill another portion entire; left you fhould be obliged to repeat a tedious roafting. If you fee the figns of a ferreous refractory pyrites, the operation muft be performed with a greater fire, and much more quickly. However, take care not to do it with too violent a fire: for a great deal of copper is confumed not only by the arfenic, but alfo by the fulphur; and this happens even in veffels fhut very clofe, when the fulphur is expelled by a fire not quite fo ftrong; which a reiterated and milder fublimation of the fulphur in a veffel both very clean and well clofed will clearly fhew.

"When the greateft part of the fulphur and the arfenic is diffipated by fuch caufes as promote colliquation, you may make a ftronger fire: but then it is proper to add a little of fome fat body; for this diffolves mineral fulphur: it changes the mixture of it in fome part, which, for inftance, confifts in a certain proportion of acid and phlogifton; and at the fame time hinders the metallic earth from being reduced into copper, by being burnt to an excefs. From thefe effects, the reafon is plain, why affayers produce lefs metals in the trying of veins of copper, lead, and tin, than fkilful fmelters do in large operations. For the former perform the roafting under a muffle, with a clear fire, and without any oily reducing menftruum; whereas the latter perform it in the middle of charcoal or of wood, which perpetually emit a reductive phlogifton.

"The darker and blacker the powder of the roafted ore appears, the more copper you may expect from it. But the redder it looks, the lefs copper and the more iron it affords; for roafted copper diffolved by fulphur or the acid of it is very black, and iron, on the contrary, very red.

PROCESS V.

The precipitation of copper out of roafted ore of the laft procefs.

"Divide the roafted ore into two parts: each of them fhall go for a centner: add to it the fame weight of fandiver, and four times as much of the black flux, and mix them well together. As for the reft, do all according to the procefs I.: the precipitated regulus will be half malleable, fometimes quite brittle, now and then pretty much like pure copper in its colour, but fometimes whitifh, and even blackifh. Whence it is moft commonly called *black copper*, tho' it is not always of fo dark a dye.

"It is eafy to conceive, that there is as great a difference between the feveral kinds of that metal called *black copper*, as there is between the pyritofe and other copper ores accidentally mixed with other metallic and femi-metallic bodies. For all the metals, the ores of which are intermixed with the copper ores, being reduced, are precipitated together with the copper, which is brought about by means of the black flux. Wherefore iron, lead, tin, the reguline part of antimony, bifmuth, moft commonly are mixed with black copper in a multitude of different proportions. Nay, it is felf-evident, that gold and filver, which are diffolvable by all thefe matters, are collected in fuch a regulus when they have been firft hidden in the ore. Befides, fulphur and arfenic are not always altogether abfent. For they can hardly be expelled fo perfectly by the many preceding roaftings, but there remain fome veftiges of them, which are not diffipated by a fudden melting, efpecially in a clofe veffel, wherein the flux fwimming at top hinders the action of the air. Nay, arfenic is rather fixed by the black flux, and affumes a reguline femi-metallic form, while it is at the fame time preferved from diffipating by the copper.

PRO-

Effaying of Ores of Copper.

PROCESS VI.

To reduce black copper into pure copper by fcorification.

" SEPARATE a fpecimen of your black copper, of the weight of two fmall docimaftical centners at leaft; and do it in the fame manner, and with the fame precautions, as if you would detect a quantity of filver in black copper.

" Then with lute and coal-duft, make a bed in the cavity of a teft moiftened: when this bed is dry, put it under the muffle of the docimaftical furnace, in the open orifice of which there muft be bright burning coals, wherewith the teft muft likewife be furrounded on all parts. When the whole is perfectly red-hot, put your copper into the fire, alone, if it contains lead; but if it is altogether deftitute of it, add a fmall quantity of glafs of lead, and with a pair of hand-bellows increafe the fire, that the whole may melt with all fpeed: this done, let the fire be made a little violent, and fuch as will fuffice to keep the metallic mafs well melted; and not much greater. The melted mafs will boil, and fcorias will be produced, that will gather at the circumference. All the heterogeneous matters being at laft partly diffipated, and partly turned to fcorias, the furface of the pure melted copper will appear. So foon as you fee it, take the pot out of the fire, and extinguifh it in water: then examine it in a balance, and if lead has been at firft mixed with your black-copper, add to the regulus remaining of the pure copper, one 15th part of its weight which the copper has loft by means of the lead, then break it with a vice; and thus you will be able to judge by its colour and malleability, and by the furface of it after it is broken, whether the purifying of it has been well performed or no. But whatever caution you may ufe in the performing of this procefs, the product will neverthelefs be always lefs in proportion than what you can get by a greater operation, provided the copper be well purified in the fmall trial.

" *Remarks.* This is the laft purifying of copper, whereby the feparation of the heterogeneous bodies begun in the foregoing procefs is completed as perfectly as it poffibly can be. For, except gold and filver, all the other metals and femimetals are partly diffipated and partly burnt, together with the fulphur and arfenic. For in the fufion they either turn of themfelves to fcoria or fumes, or this is performed by means of iron, which chiefly abforbs femimetals, fulphur and arfenic, and the deftruction of it is at the fame time accelerated by them. Thus the copper is precipitated out of them pure; for it is felf-evident, that the unmetallic earth is expelled, the copper being reduced from a vitrefcent terreftrial to a metallic ftate, and the arfenic being diffipated by means of which the faid earth has been joined to the coarfer regulufes of the firft fufion. But there is at the fame time a good quantity of the copper that gets into the fcorias: however, a great part of it may be reduced out of them by repeating the fufion.

" The fire in this procefs muft be applied with all imaginable fpeed, to make it foon run: for if you neglect this, much of your copper is burnt; becaufe copper that is only red-hot, cleaves much fooner, and in much greater quantity, into half-fcorified fcales, than it is diminifhed in the fame time when melted. However, too impetuous a fire, and one much greater than is neceffary for the fufion of it, deftroys a much greater quantity of it than a fire fufficient only to put it in fufion would do. For this reafon, when the purifying is finifhed, the body melted muft be extinguifhed in water together with the veffel, left, being already grown hard, it fhould ftill remain hot for a while; which muft be done very carefully to prevent dangerous explofions.

" The fcoria of the above procefs frequently contains copper. To extract which, let two or three docimaftical centners of the fcoria, if it be charged with fulphur, be beat to a fubtil powder, and mix it, either alone, or, if its refractory nature requires it, with fome very fufible common pounded glafs without a reducing faline flux, and melt it in a clofe veffel, and in a fire having a draught of air; by which you will obtain a regulus.

" But when the fcoria has little or no fulphur at all in it, take one centner of it, and with the black flux manage it as you do the fufible copper ore, (procefs I.) by which you will have a pure regulus."

PROCESS VII.

The following procefs is tranflated from Mr Gellert's *Elements of Effaying*, and defcribes a new method of effaying ores, concerning which, fee the fection *Of Effaying in general*, p. 4922, col. 2.

To effay copper ores.

ROAST a quintal of ore [in the manner defcribed in procefs IV.]; add to it an equal quantity of borax, half a quintal of fufible glafs, and a quarter of a quintal of pitch: put the mixture in a crucible, the inner furface of which has been previoufly rubbed with a fluid pafte of charcoal-duft and water: cover the whole with pounded glafs mixed with a little borax, or with decrepitated fea-falt: put a lid on the crucible, which you will place in an air-furnace, or in a blaft-furnace: when the fire fhall have extended to the bottom of the coals, let it be excited brifkly during half an hour, that the crucible may be of a brifk red colour: then withdraw the crucible, and when it is cold break it: obferve if the fcoria be well made: feparate the regulus, which ought to be femi-ductile; and weigh it. This regulus is black copper; which muft be purified, as in procefs VI.

If the ore be very poor, and inveloped in much earthy and ftony matters; to a quintal of it, a quintal and a half of borax, a quarter of a quintal of pitch, and ten pounds of calx of lead or minium, muft be added. The calx of lead will be revived, and will unite with the fcattered particles of the copper, and together with thefe will fall to the bottom of the crucible, forming a compound regulus. When the ores of copper are very rich, half a quintal of borax and a quarter of a quintal of glafs will be fufficient for the reduction. If the ore is charged with much antimony, a half or three quarters of a quintal of clean iron-filings may be added; otherwife the large quantity of antimony might deftroy the copper, efpecially if the ore contained no lead. If iron be contained in copper ore, as in pyrites, fome pounds of antimony, or of its regulus, may be

Essaying of Ores of Copper.

be added in the essay; as these substances more readily unite with iron than with copper, and therefore disengage the latter metal from the former.

PROCESS VII.

To essay Ores of Copper by humid Solution.

Some pyrites and ores contain so small a quantity of copper, that it cannot be separated by the above processes, but is destroyed by the repeated roastings and fusions. These, and indeed any copper-ores, may be essayed by humid solution, or by menstruums.

1. By roasting a sulphureous ore, the sulphur is burnt or decomposed, its phlogiston with part of the acid evaporating, while the remaining part of the acid combines with the metals, especially with the copper and iron contained in the ore. Accordingly, from an ore thus roasted, a vitriolic solution may be obtained by lixiviation with warm water, especially if the ore has been exposed, during a few days after it has been roasted, to a moist air; as the water thus gradually applied unites better with the combination of the metallic calxes with the concentrated vitriolic acid of the sulphur: but all the copper is not thus reduced by one operation to a vitriol. More sulphur must therefore be combined with the residuous ore by fusion, and must be again burnt off, that the remaining part of the copper may be attacked by some of the acid of the sulphur. By repeating this operation, almost all the copper and iron will be reduced to a vitriolic lixivium, from which the copper may be separated and precipitated by adding clean pieces of iron.

2. Copper-ores may be more easily essayed by humid solution in the following manner:

Roast the mineralized ores in the manner directed in Process IV. and pulverise them. If the ores be calciform, they do not require a previous roasting. Put this powder into a matrass capable of containing ten times the quantity of the ore; pour upon the ore some water: set the matrass in a sand-bath, that the water may boil: pour off the lixivium: add to the residuous ore more water, with some vitriolic or marine acid: digest as before in the sand-bath, and add this lixivium to the former: repeat this operation, till you find that the acid liquor dissolves no more metal.

By adding clean plates of iron you may precipitate the copper, which ought then to be collected, fused with a little borax and charcoal dust, and weighed.

We may remark, that although copper is not soluble by a dilute vitriolic acid, yet the calx of it obtained by roasting the ore, and also the calciform ores, are readily soluble in that acid.

3. Stahl advises to essay copper-ores by boiling them, after they have been roasted and powdered, in water, together with tartar and common salt, or with alum and common salt: but we have not found this method so effectual as the preceding.

PROCESS VIII.

Dr Fordyce's method of essaying copper ores, by means of Aqua Regia. [Phil. Trans. for 1781, vol. lxxx. art. 3.]

This method consists only in pouring a quantity of an aqua regia composed of equal parts of the nitrous and muriatic acids upon a small quantity of the ore in powder, till a fresh affusion of the menstruum shews no green or blue tinge; by which means all the metalline part of the ore will be dissolved. It is then to be precipitated by means of a solution of fixed alkali, or volatile alkali cautiously managed will answer the same purpose. The metal then appears in form of a green precipitate called *green verditer;* but is mixed with what calcareous earth might have been contained in the ore; which the acids would dissolve, and the fixed alkali, if that kind was used, would precipitate. The caustic volatile alkali would not throw down this earth, and is therefore to be preferred to any other; but care must be taken to hit the point of saturation very exactly with it, as it violently dissolves the metal if added in too great quantity. Dr Fordyce orders this green calx to be dissolved in vitriolic acid, and then, by adding a piece of clean iron to the solution, all the copper contained in the ore will be obtained in its metallic form.

This method can be subject to no fallacy, unless the ore contains aluminous matter, in which case some of the earth of alum will be mixed with the metal, as that earth will be precipitated by fixed alkali, by caustic volatile alkali, and by iron. This, however, may very effectually be prevented by dissolving the green calx first in volatile alkali, and then in vitriolic acid. It is even probable, that by reducing the ore to a very fine powder, and treating it with caustic alkali, all the metal might be separated from the ore, without the trouble of using aqua regia. For the principles on which this method is conducted, see the article Chemistry *passim.*

Sect. V. *Ores of Lead.*

Lead is seldom found native (E) and malleable. Neither, says Mr Macquer (F), is it found in form of calx or precipitate, as copper is, because it is much less liable to lose its phlogiston by the action of air and water: therefore almost all lead is found naturally mineralized.

Lead is generally mineralized by sulphur (G). Its ores have a dark white, but a shining metallic colour. These

(E) Cronstedt doubts whether any native lead has been found. Linnæus says, he has seen what externally appeared to be such.

(F) But he is mistaken. As lead unites strongly with vitriolic acid, we might expect to meet ochres of this metal as well as of copper. Accordingly, we find some calciform ores of lead. 1. A pure calx of lead, in form of a friable ochre, *cerussa nativa,* found on the surface of galena; or it is indurated with a radiated or fibrous texture, of a white or yellowish green colour, and resembling spar; it is called *spatum plumbi, sparry lead-ore,* and *lead-spar.* 2. A calx of lead is found mixed with calx of arsenic, forming the ore called *arsenicated lead-spar.* Sometimes also that calx is mixed with calcareous earth.

(G) Lead is mineralised, 1. With sulphur; such are the several kinds of steel-grained and tesselated galenas, which also contain generally some silver. 2. With sulphurated iron and silver. It is fine-grained or tesselated, and is distin-

Ores of Lead These ores, although they form irregular masses, are internally regularly disposed, and seem to be composed of cubes of different sizes applied to each other, but not adherent. These ores are generally distinguished by the name of *Galena*. They commonly contain about three quarters of lead and a quarter of sulphur. They are accordingly heavy and fusible, although much less so than pure lead.

Most lead-ores contain silver; none but those of Willach in Carinthia are known to be quite free from it: some of them contain so much of it, that they are considered as improper ores of silver. The smaller the cubes of galena are, the larger quantity of silver has been remarked to be generally contained.

§ 2. *Lead ores may be essayed*, 1. By means of the black flux, in the manner directed by Mr Cramer, as follows:

"Let one or more quintals of this ore be grossly powdered, and roasted in a test till no more sulphureous vapours be exhaled, and then reduced to a finer powder; it is then to be accurately mixed with twice its weight of black flux, a fourth part of its weight of clean filings of iron and of borax. The mixture is to be put into a good crucible, or rather into a test; it is then to be covered with a thickness of two or three fingers of decrepitated sea-salt; the crucible is to be closed, and placed in a melting furnace, which is to be filled with unlighted charcoal, so that the top of the crucible shall be covered with it. Lighted coals are then to be thrown upon the unkindled charcoal, and the whole is left to kindle slowly, till the crucible be red-hot; soon after which a hissing noise proceeds from the crucible, which is occasioned by the reduction of the lead: the same degree of fire is to be maintained while this noise continues, and is afterwards to be suddenly increased, so as to make a perfect fusion; in which state it is to be continued during a quarter of an hour; after which it is to be extinguished; and the operation is then finished."—The filings of iron are added to the mixture, to absorb the sulphur, a certain quantity of which generally remains united with the lead-ore, notwithstanding the roasting. We need not fear lest this metal should unite with the lead and alter its purity; because, although the sulphur should not hinder it, these two metals cannot be united. The refractory quality of the iron does not impede the fusion; for the union it forms with the sulphur renders it so fusible, that it becomes itself a kind of flux.—This addition of iron in the essay of lead-ores would be useless, if the ores were sufficiently roasted, so that no sulphur should remain.

Or, 2. By the following process of Mr Gellert.

"Mix a quintal of roasted-lead ore with a quintal of calcined borax, half a quintal of glass finely pulverised, a quarter of a quintal of pitch, and as much of clean iron-filings: put this mixture into a crucible wetted with charcoal-dust and water: place the crucible before the nozzle of the bellows of a forge, and when it is red raise the fire during 15 or 20 minutes; then withdraw the crucible, and break it when cold."

Some very fusible ores, such as the galena of Derbyshire, may be essayed, as large quantities of it are smelted, without previous roasting, and without addition, merely by fusion during a certain time. For this purpose nothing more is requisite than to keep the ore melted in a crucible with a moderate heat, till all the sulphur is destroyed, and the metal be collected. To prevent the destruction of any part of the metal after it is separated from the sulphur, some charcoal dust may be thrown over the ore, when put into the crucible; but if the galena be mixed with pyrites, especially arsenical pyrites, it requires much roasting and saline fluxes.

Sect. VI. *Tin Ores.*

Ores of Tin § 1. Tin is very seldom found pure, but almost always mineralized, and chiefly by arsenic.

The richest ore of tin is of an irregular form, of a black or tarnished colour, and almost the heaviest of all ores. The cause of this extraordinary weight is, that it contains much more arsenic than sulphur, whereas most ores contain more sulphur than arsenic.

The most common tin ore is of the colour of rust, which proceeds from a quantity of iron, or of iron-ore mixed with it. The tin-ores of Saxony and Bohemia appear to be all of this kind.

One kind of tin-ore is semi-transparent and like spar. Lastly, several kinds of garnets are enumerated by mineralogists among tin-ores, because they actually contain tin.

The county of Cornwall, in England, is very rich in tin-ores; and the tin contained in them is very pure. From tin-mines in the East Indies tin is brought, called *Malacca tin*. No mines of tin have been dicovered in France; only in Bretagne garnets are found which contain some tin.

Native tin is said to have been found in Saxony and Malacca. Its ores are all of the calciform kind, excepting black-lead, which appears to be tin mineralized by sulphur and iron.

The calciform ores of tin are, 1. Tin-stone, which is of a blackish-brown colour, and of no determinate figure; and tin-grains, or crystals of tin, which resemble garnets, and are of a spherical or polygonal figure, which they have probably acquired by the attrition of their angles. The tin-stone seems to consist of attrited tin-grains. This ore is calx of tin united with calx of arsenic, and frequently with calx of iron. 2. Garnets are said to contain calx of tin united with calx of iron. 3. Manganese is said also to contain tin.

§ 2. *Ores of tin may be essayed* in the same manner, according to Cramer, as he directed for the essay of lead-ores, *supra*. He further makes upon this essay the following remarks.

1. Tin-ore, on account of its greater gravity, admits better of being separated, by elutriation or washing, from earths, stones, and lighter ores. 2. A most exact separation of earths and stones ought to be made, because the scorification of these by fluxes requires such a heat as would destroy the reduced tin. 3. The iron ought to be separated by a magnet. 4. By a previous roasting, the arsenic is dissipated, which would otherwise carry off a great deal of tin along with it in a melting

distinguished from the former by yielding a black slag when scorified, whereas the former yields a yellow slag. 3. With sulphurated antimony and silver. *Plumbum stibiatum Linnæi.* Its colour is similar to that of galena, and its texture is striated. 4. With sulphur and arsenic. This cure is soft, almost malleable, like lead. From this ore lead may be melted by the flame of a candle.

Ores of Iron

ing heat, would change another part of it into afhes, and would vitiate the remaining tin. 5. The effay of tin is very precarious and uncertain; becaufe tin once reduced is eafily deftructible by the fire, and by the faline fluxes requifite for the reduction.

Mr Gellert directs, that ores of tin fhould be effayed in the following manner:

"Mix a quintal of tin-ore, wafhed, pulverized, and twice roafted, with half a quintal of calcined borax, and half a quintal of pulverized pitch: thefe are to be put into a crucible moiftened with charcoal-duft and water, and the crucible placed in an air-furnace: after the pitch is burnt, give a violent fire during a quarter of an hour; and then withdraw your crucible. If the ore be not very well wafhed from the earthy matters, as it ought to be, a larger quantity of borax is requifite, with fome powdered glafs, by which the too quick fufion of the borax is retarded, and the precipitation of the earthy matters is prevented. If the ore contains iron, to the above mixture may be added fome alkaline falt.

SECT. VII. *Ores of Iron.*

§. 1. IRON is feldom found in its metallic ftate, and free from admixture; though Cramer gives an account of an ore which needs only to be put into a forge, and heated to a welding heat. Several fands and earths alfo have the appearance of iron, and are even attractable by a magnet. The ore mentioned by Cramer is found vitrified; with moderate blows the fcorias are thrown out, and a mafs of iron obtained, which, by being put into the forge again, gives tough iron without any other procefs. But in general this metal is found in the ftate of a calx; or, though it is combined with a great quantity of the principle of inflammability, it has feldom enough of the metallic form; and it is very often intermixed with a certain proportion of fulphur. The minerals wrought for iron are three, viz. iron-ore, iron-ftone, and bog-ore.

The iron ore is found in veins as the ores of other metals are, and the appearance is very various; fometimes it has a rufty iron colour refembling that of iron; fometimes it has a reddifh caft; often it is formed into a fort of cryftallizations which are protuberant knobs on the outfide; and thefe confift of fibres tending to a common centre; and it is of a dark colour like coagulated blood. It is called *hæmatites*, or *blood-ftone;* and confifts of a calx of iron with a fmall quantity of vitriolic acid.

Iron-ftone in this country is clay found in ftrata with coal; but which contains a large quantity of iron, fo as to make the working profitable. Sometimes it has little appearance of iron; but, when burnt with a certain degree of heat, it becomes of a deep red.

The bog-ore is an ochre of iron, and is found generally in low fituations, and in fprings containing a fmall quantity of iron, which flowing over thefe grounds depofits it in the form of ochre; and after a number of ages it proves a rich mine of iron, and it is extracted from a calx of this kind in many parts of the world. There is alfo a particular kind of fpar found in different countries of a pale blue colour, fo that from its firft appearance we would expect copper; but it contains a fmall quantity of iron, and is a combination of the metal with inflammable matter, as in Pruffian blue.

Effaying of Ores of Iron.

The loadftone is a noted iron ore. It is always found in veins, and it is alleged that it is only poffeffed of its magnetic qualities when near the furface. In appearance, it does not differ from many of the ores of iron, and treated as an ore, it affords a confiderable quantity of metal.

Neither is iron generally mineralized fo diftinctly as other metals are, unlefs in pyrites and ores of other metals.

Moft of the minerals called *iron ores* have an earthy, rufty, yellowifh, or brownifh appearance, which proceeds from the facility with which the true iron ores are decompofed.

Iron is the moft common and moft abundant of all metals. In Europe, at leaft, we cannot find an earth, a fand, a chalk, a clay, a vitrifiable or calcinable ftone, or even the afhes of any fubftance, which do not contain an earth convertible into iron. All earths and ftones which are naturally yellow or red, and all thofe which acquire thefe colours by calcination, receive them from the ferruginous earth mixed with them. The yellow and red ochres confift almoft folely of this earth: the black and heavy fands are generally very ferruginous.

The iron ore moft commonly found is a ftone of the colour of ruft, of an intermediate weight betwixt thofe of ores in general and of unmetallic ftones. This ore has no determinate form, and eafily furnifhes an iron of good quality.

Blood-ftone or hematites, fanguine or red chalk, and emery, are iron ores; fome of which, for inftance blood-ftone, are almoft all iron. Moft of thefe fubftances require but a flight calcination to be rendered very attractable by a magnet, and foluble in aqua fortis; but the iron obtained from them is of a bad quality, and they are therefore neglected. Iron from the hematites is very brittle; that obtained from ochres is red-fhort. All thefe iron ores are fo refractory, that they can fcarcely be fufed.

Iron ores are very various in their form; or rather they have no determinate form. Sometimes they are earths, fometimes ftones, fometimes grains. Accordingly, thofe naturalifts who attend only to the external form of things in claffing and fubdividing minerals, have been obliged to multiply the names of iron ores: hence they are called *iron ores in form of peafe, of beans, of coriander feeds, of pepper-corns, of cinnamon,* &c. which Mr Cramer treats as ridiculous trifles,

§. 2. *Ores of iron may be effayed* by the following procefs.

PROCESS I.

[CRAMER's *Art of Affaying*, Proc. 54.]

To reduce a precipitate iron out of its ore in a clofe veffel.

"ROAST for a few minutes in a teft under a muffle, and with a pretty ftrong fire, two centners of the fmall weight of your iron ore grofsly pulverifed; that the volatiles may be diffipated in part, and the ore itfelf be foftened in cafe it fhould be too hard. When it is

Effaying of Ores of Iron.

is grown cold, beat it extremely fine, and roaft it a fecond time, as you do the copper-ore, but in a much ftronger fire, till it no longer emits any fmell; then let it grow cold again. Compofe a flux of three parts of the white flux, with one part of fufible pulverifed glafs, or of the like fterile unfulphureous fcorias, and add fandiver and coal-duft, of each one half-part; add of this flux three times the quantity of your roafted ore, and mix the whole very well together; then choofe a very good crucible, well rubbed with lute within, to ftop the pores that may be here and there unfeen; put into it the ore mixed with the flux; cover it over with common falt; and fhut it clofe with a tile, and with lute applied to the points.

"Put the wind-furnace upon its bottom-part, having a bed made of coal-duft. Introduce befides into the furnace a fmall grate fupported on its iron bars, and a ftone upon it, whereon the crucible may ftand as on a fupport: furround the whole with hard coals, not very large, and light them at top. When the veffel begins to grow red, which is indicated by the common falt's ceafing to crackle, ftop with grofs lute the holes of the bottom-part, except that in which the nozzle of the bellows is received: blow the fire, and excite it with great force, adding now and then frefh fuel, that the veffel may never be naked at top: having thus continued your fire in its full ftrength for three quarters of an hour, or for a whole hour, take next the veffel out of it, and ftrike feveral times the pavement upon which it is fet, that the fmall grains of iron which happen to be difperfed may be collected into a regulus, which you will find after having broken the veffel.

"When the regulus is weighed, try its malleability: then make it red-hot; and when fo, ftrike it with a hammer: if it bears the ftrokes of a hammer, both when red-hot and when cold, and extends a little, you may pronounce your iron very good; but if, when either hot or cold, it proves brittle, you may judge it to be not quite pure, but ftill in a femi-mineral condition.

"*Remarks.* The arfenic, but efpecially the fulphur, muft be diffipated by roafting: for the former renders the iron brittle; and the latter not only does the fame, but, being managed in a clofe veffel, with a faline alkaline flux, turns to liver of fulphur; to the action of which iron yielding in every refpect, it can upon no account be precipitated; and if not the whole, a great part of it, at leaft, is retained by the fulphureous fcoria; fo that in this cafe you commonly in vain look for a regulus.

"The iron obtained from this firft precipitation has hardly ever the requifite ductility, but is rather brittle: the reafon of which is, that the fulphur and arfenic remain in it; for notwithftanding that the greateft part of thefe is diffipated by roafting, yet fome part adheres fo ftrictly, that it can never be feparated but with abforbent, terreftrial, alkaline ingredients, that change the nature of the fulphur. For which reafon, in larger operations, they add quicklime, or marble ftones that turn into quicklime; which, while they abforb the faid minerals, are, by it, and by help of the deftroyed part of the iron, brought to a fufion, and turn to a vitrified fcoria; although, at other times, they refift fo much by their own nature a vitrification. Another caufe of the brittlenefs of iron is the unmetallic earth, when it is not yet feparated from it; for the iron ore contains a great quantity of it, and in the melting remains joined with the reguline part: whence the iron is rendered very coarfe and brittle. Some iron ores are altogether untractable: neverthelefs, the regulufes produced out of them, when broken, have fometimes a neat femi-metallic look; which proceeds undoubtedly from a mixture of a fmall quantity of fome other metal or femi-metal."

PROCESS II.

[The following Procefs for effaying iron ores, and ferruginous ftones and earths, is extracted from Mr Gellert's *Elements of Effaying.*]

"Roast two quintals of iron ore, or of ferruginous earth: divide the roafted matter into two equal parts; to each of which add half a quintal of pulverifed glafs, if the fubftance be fufible and contain much metal; but if otherwife, add alfo half a quintal of calcined borax. If the roafting has entirely difengaged the fulphur and arfenic, an eighth part, or even half a quintal, of quicklime may be added. With the above matters, mix twelve pounds of charcoal-powder.

"Take a crucible, and cover the bottom and fides of its inner furface with a pafte made of three parts of charcoal-duft and one part of clay beat together. In the hollow left in this pafte put the above mixture; prefs it lightly down; cover it with pulverifed glafs; and put on the lid of the crucible.

"Place two fuch crucibles at the diftance of about four fingers from the air-pipe, in fuch a manner that the air fhall pafs betwixt them at about the third part of the height from the bottom: fill the fpace betwixt the two crucibles with coals of a moderate fize: throw lighted coals upon them, that the fire may defcend and make them red-hot from top to bottom: at firft let the bellows blow foftly, and afterwards ftrongly during an hour, or an hour and a quarter: then take away the crucible, and break it when cold. A regulus will be found in the bottom, and fometimes fome fmall grains of iron in the fcoria, which muft be feparated and weighed along with the regulus: then try the regulus, whether it can be extended under the hammer, when hot and when cold.

"*Remarks.* To difengage a metal from the earthy matters mixed with it by fire, we muft change thefe matters into fcoria or glafs. This change may be effected by adding fome fubftance capable of diffolving thefe matters; that is, of converting them into a fcoria or glafs, from which the metallic matters may, by their weight, feparate and form a regulus at bottom. Fixed alkali, which is an ingredient of the black and of the white flux, is a powerful folvent of earths and ftones: but the alkali does alfo diffolve iron, efpecially when this is in a calcined or earthy ftate; and this folution is fo much more complete, as the fire is longer applied. Hence, in ordinary effays, where an alkaline falt is ufed, little or no regulus of iron is obtained. Now, glafs acts upon and diffolves earths and ftones; but not, or very little, iron: confequently glafs is the beft flux for fuch effays, and experience confirms this affertion. If the ore contains but little iron, we may alfo

Ores of Mercury.

alſo add to the glaſs ſome borax; but borax cannot be employed ſingly, becauſe it very ſoon fuſes, and ſeparates from the ore before the metal is revived. Quicklime is added, not only to abſorb the ſulphur and arſenic remaining in the ore, but alſo becauſe it diſſolves and vitrifies the ſtony and earthy matters of iron ores, which are generally argillaceous. For which reaſon, in the large operations for ſmelting iron ore, quicklime, and even in certain caſes gypſum, are commonly added to facilitate the fuſion.

The reduction of iron-ore, and even the fuſion of iron, requires a violent and long-continued heat: therefore, in this operation, we muſt not employ an inflammable ſubſtance, as pitch, that is ſoon conſumed, but charcoal pulveriſed, which in cloſe veſſels is not ſenſibly waſted. Too much charcoal muſt not be added, elſe it will prevent the action of the glaſs upon the earthy matter of the ore, and conſequently the ſeparation of the metallic part. Experiments have taught me, that one part of charcoal-duſt to eight parts of oar was the beſt proportion.

When iron is ſurrounded by charcoal, it is not decompoſed or deſtroyed: hence the iron of the ore, which ſinks into the hollow made of paſte of charcoal-duſt and clay, remains there unhurt. The clay is added in this paſte to render it more compact, and to keep the fluid iron collected together.

The air is directed betwixt the crucibles; becauſe if it was thrown directly upon them, they would ſcarcely be able to reſiſt the heat. The ſpace betwixt the air-pipe and the crucibles ought to be conſtantly filled with charcoal, to prevent the cold air from touching the crucibles. Ductile and malleable iron is ſeldom obtained in this firſt operation. The ſulphur and arſenic, and frequently alſo an earthy matter adhering to the iron, prevent theſe qualities.

Sect. VIII. *Ores of Mercury.*

§ 1. Mercury is ſometimes found pure, fluid, and in its proper metallic ſtate, only mixed with earths and ſtones. Such are the ores of mercury found near Montpelier, in Tuſcany, and in other places.

But the largeſt quantity of the mercury found in the earth is mineraliſed by ſulphur, and conſequently is in the form of cinnabar.

Mercury is never mineraliſed by arſenic. The richeſt mine of mercury is that of Almaden, in Spain.

Linnæus and Cronſtedt mention a ſingular ore, in which the mercury is *mineraliſed by ſulphur and by copper*. It is ſaid to be of a blackiſh-grey colour, of a glaſſy texture, and brittle. When the mercury and ſulphur are expelled by fire, the copper is diſcovered by giving an opake red colour to glaſs of borax, which, by continuance and increaſe of heat, becomes green and tranſparent.

§ 2. Cramer directs, that *ores of mercury ſhould be eſſayed* by the following Proceſſes.

PROCESS I.

To ſeparate Mercury out of an unſulphureous Ore by Diſtillation.

"Take a lump of the pulveriſed ore, one common pound, which muſt ſtand for one centner: put it into a glaſs retort perfectly clean, well loricated, or coated up to half the length of its neck: this muſt be very long, and turned backwards with ſuch a declivity, that a glaſs recipient may be perpendicularly applied to it: but you muſt chooſe a retort ſmall enough, that the belly of it may be filled hardly two-thirds with the ore: this retort muſt be placed ſo, that nothing of the fluid adherent to the neck of it may fall into the cavity of the belly, but that the whole may run forward into the recipient. Finally, have a ſmall recipient full of cold water: let it be perpendicularly ſituated, and receive the neck of the retort in ſuch manner that the extremity of it be hardly one half-inch immerſed into the water.

Eſſaying of Ores of Mercury.

"Let the retort be ſurrounded with hot burning coals placed at ſome diſtance in form of a circle, leſt the veſſel ſhould burſt by too ſudden a heat: then by degrees bring the burning coals nearer and nearer, and at laſt ſurround the whole retort with them and with freſh charcoal, that it may grow ſlightly red-hot: this fire having been continued for an hour, let the retort cool of itſelf: then ſtrike the neck of it gently, that the large drops which are always adherent to it may fall into the recipient: let the recipient be taken away, and the water ſeparated from the mercury by filtration, and let the mercury be weighed. This operation may be more conveniently performed in a ſand-bath; in which caſe the pot containing the ſand muſt be middling red-hot, and the retort be able to touch the bottom of it immediately; nor is it then neceſſary that the retort be loricated."

PROCESS II.

To revive Mercury from a ſulphureous Cinnabar-ore.

"Beat your ore extremely fine, and mix it exactly with an equal portion of iron-filings, not ruſty; proceed to diſtill it with the ſame apparatus as in the former proceſs, but urge it with the ſtrongeſt fire that can be made.

"Cinnabar may be ſeparated from ſtones by ſublimation thus: Beat it to a fine powder, and put it into a ſmall narrow glaſs or earthen cucurbit, the belly of which it muſt not fill more than one-third part: ſtop the orifice at top; this muſt be very narrow, to hinder the free action of the air. Put this ſmall cucurbit in an earthen pot above two inches wide in diameter, and gather ſand around this pot about as high as the pulveriſed ore riſes in the cucurbit. Then put it upon burning coals in ſuch manner that the bottom of the pot may be middling red-hot. Thus will your cinnabar aſcend and form a ſolid ponderous ring, which muſt be got out by breaking the veſſel."

Sect. IX. *Ore of the Regulus of Antimony.*

Native regulus of antimony was firſt obſerved by Mr Swab, in Sweden, in the mine of Salberg, and deſcribed by him in the memoirs of the Swediſh Academy in 1749. Mr Wallerius mentions it in his Mineralogy.

Regulus of antimony is generally united with ſulphur, with which it forms antimony, which ought to be conſidered as a true ore of the regulus of antimony.

Another ore of regulus of antimony is alſo known, of

Ores of Antimony. of a red colour, in which the regulus is mineralifed both by arfenic and by fulphur. This ore refembles fome iron ores, and fome kinds of blend. It is diftinguifhed by its great fufibility, which is fuch, that it may be eafily melted by the flame of a candle.

The *native regulus* of antimony, by Von Sweb, is faid by that author to have differed from the regulus of antimony obtained from ores, in thefe two properties, that it was capable of being eafily amalgamated with mercury, and that its calx fhot into cryftals during the cooling.

Befides the ores of regulus of antimony enumerated above, this femimetal is alfo found in ores of other metallic fubftances, as in the *plumofe filver-ore*, and in the *ftibiated lead-ore*.

§ 2. The *ores of antimony may be effayed* by the following proceffes defcribed by Mr Cramer.

PROCESS I.

To obtain antimony from its ore.

"Choose a melting crucible, or an earthen pot not glazed, that may contain fome common pounds of the ore of antimony, broken into fmall bits. Bore at the bottom of the crucible fome fmall holes, two lines in diameter. Let the bottom of the veffel be received by the orifice of a fmaller one, upon which it muft be put; and when the ore is put into it, let it be covered with a tile, and all the joints be ftopped with lute.

"Put thefe veffels upon the pavement of a heath, and put ftones all around them at the diftance of fix inches. Fill this intermediate fpace with afhes, fo high that the inferior pot be covered to the upper brim. Then put frefh and burning coals upon it, and with a pair of hand-bellows excite the fire, till the upper veffels grow red-hot: take off the fire a quarter of an hour after; and when the veffels are grown cold, open them. You will find that the melted antimony has run through the holes made at the bottom of the upper veffel into the inferior one, where it is collected."

PROCESS II.

To roaft crude antimony, or its ore, with or without addition.

"Choose an earthen, flat, low difh, not glazed; and if it cannot bear being made middling red-hot, cover it over with a coat of lute without. Spread it thinly over with crude antimony, or with its ore, beaten to a pretty coarfe powder, not exceeding a few ounces at once. Put the difh upon a fire-pan, having a few burning coals in it: increafe the fire till it begins to fmoke a little. Meanwhile you muft inceffantly move the powder with a piece of new tobacco-pipe; for this caufes the fulphur to evaporate the fooner. If you increafe the fire a little too foon, the powder immediately gathers into large clots, or even begins to melt. When this happens, take it immediately off the fire before it melts entirely. Then pulverife it again, and finally make a gentle fire under it. Your black fhining powder will affume an afh-colour almoft like that of earth, and become more refractory in the fire; wherefore you may then increafe the fire till your powder grows middling red-hot, and let it laft till it ceafes to fmoke. If you add to your crude antimony pulverifed, half or an equal quantity of charcoal-duft, and perform the reft as above, the roafting will be done more conveniently: for it does not gather fo eafily into clots, and melts with much greater difficulty. When part of the fulphur is evaporated, add fome fat to it at feveral times. Thus you will fooner finifh the operation, and the remaining calx will not be burnt to excefs. However, if it be thus expofed to too violent and long-lafting a fire, a great quantity of it evaporates; nor does it ceafe entirely to fmoke in a great fire. And it will be enough, if, growing middling red-hot, it does no longer emit the unpleafant fmell of the acid of fulphur."

PROCESS III.

To reduce a calx of antimony into a femi-metallic regulus.

"Mix fome calx of antimony with a quarter part of the black flux, and put it into the crucible. Cover the veffel with a tile; make the fire as quickly as the veffel can bear it, but not greater than is neceffary to melt the flux. When the whole has been well in fufion for half a quarter of an hour (which may be tried with a tobacco-pipe, taking off the tile) pour it into the melting cone, which muft be warm and done over with tallow. Then immediately ftrike the cone feveral times. You will find, when the cone is inverted, a regulus, above which is a faline fcoria."

The methods of *calcining antimony by means of nitre*, are defcribed under Chemistry, n° 489—459; and thofe of obtaining a *regulus of antimony* without a previous calcination or roafting, by throwing a mixture of powdered antimony, tartar, and nitre, into a red-hot crucible, and by fufing this mixture, and of obtaining a *martial regulus of antimony*, are defcribed at the article Regulus.

Sect. X. *Ores of Bifmuth.*

Ores of Bifmuth. § 1. Bismuth is found *native*, refembling the regulus of bifmuth.

An *ochre* of bifmuth, of a whitifh yellow colour, is mentioned by Cronftedt; and is different from the ore improperly called *flowers of bifmuth*, which is a calx of cobalt.

Bifmuth is mineralifed, 1. By *fulphur*. This ore has the appearance of galena. 2. With *fulphurated iron*. Bifmuth is found alfo in cobalts, and in fome ores of filver.

§ 2. *Ores of Bifmuth* may be *effayed* by the following procefs.

PROCESS I.

To melt bifmuth from its ore.

"Bismuth ore may be melted with the fame apparatus as was directed for the fufion of crude antimony out of its ore. Or you may beat your ore to a very fine powder, with the black flux, fandiver, and common falt, in a clofe veffel, like the ore of lead, or of tin, and melt it in a middling fire, having a draught of air. But as this femi-metal is deftructible and volatile, you muft as quick as poffible apply to it that degree of fire which the flux requires to be melted; and

Ores of Cobalt.

and so soon as it is well melted, the vessel must be taken out of the fire; and when it is grown quite cold and broken, you will find your regulus."

Mr Gellert directs that ores of bismuth should be essayed by fusing a quintal of pulverised ore with half a quintal of calcined borax and half a quintal of pulverised glass, in order to vitrify the adherent earths and stones which invelop the bismuth. But probably the heat requisite for this vitrification would volatilise part of the bismuth.

If the ore be of the kinds above described, mineralised by sulphur, or by sulphur and iron, a previous roasting would be expedient, which may be performed in the same manner as is directed for the roasting of antimony.

SECT. XI. *Ores of the Regulus of Cobalt.*

COBALT is a grey-coloured mineral, with more or less of a metallic appearance. Its grain is close; it is compact and heavy, and frequently covered with an efflorescence of peach-coloured flowers. Of this several kinds are known*. All the true cobalts contain the semi-metal called *regulus* of cobalt, the calx of which becomes blue by vitrification. This regulus is mineralised in cobalt by sulphur, and especially by a large quantity of arsenic. Some cobalts also contain bismuth and silver.

* See *Cobalt.*

Authors have given the name of *cobalt* to many minerals, although they do not contain the semi-metal above-mentioned, but only because they externally resemble the ore of the regulus of cobalt. But these minerals can only be considered as false cobalts. They are distinguishable from true cobalt by trying whether they can yield the blue glass called *smalt*, and the sympathetic ink. The red efflorescence is also a mark by which true cobalt is distinguishable from the false: but this efflorescence only happens when the ore has been exposed to a moist air.

The principal mines of cobalt are in Saxony, where they are dug for the sake of obtaining zaffre, azure-blue or smalt, and arsenic. Very fine cobalt is also found in the Pyrenean mountains. It has been likewise found in Cornwall and Scotland. And that it is in the eastern parts of Asia, appears from the blue colouring on old oriental porcelain: but probably the mines discovered in these countries are nearly exhausted, as considerable quantities of zaffre and smalt are exported from Europe to China.

Cobalt is heavier than most other ores, from the large quantity of arsenic it contains; and in this respect it resembles the ore of tin.

Besides the grey or ash-coloured cobalt above described, which is the most frequent, other cobalts are found of various colours and textures, mixed with various substances. Wallerius enumerates six species of cobalts. 1. The *ash-coloured ore*, which is regulus of cobalt mineralised by arsenic, consisting of shining leaden-coloured grains. Some ores of this kind are compact resembling steel, and others are of a loose texture and friable. 3. The *specular ore* is black, shining like a mirror, and laminated. This species is very rare; and is supposed by Wallerius to be a foliated spar, or selenites mixed with cobalt. 3. The *vitreous*, or *slag-like ore*, is of a bluish, shining colour, compact, or spongy. 4. *Crystallized ore*, is a grey, deep-coloured cobalt, consisting of clusters of cubical, pyramidal, prismatic crystals. 5. *Flowers of cobalt*, red, yellow, or violet. These flowers seem to be formed from some of the above-described compact ores, decomposed by exposure to moist air. This decomposition is similar to that which happens to ferruginous and cupreous pyrites. 6. The *earthy cobalt* is of a greenish white, or of a yellow colour, and of a soft and friable texture. This species seems to be an ochre of cobalt; and is formed perhaps from the flowers of cobalt further decomposed, in the same manner as a martial ochre is formed from the saline efflorescence of decomposing pyrites, when this efflorescence is further decomposed by exposure to moist air; by which the vitriolic acid contained in it is expelled, and the efflorescence is changed from a saline state to that of an ochre or calx.

Ores of Zinc.

Besides these proper ores, cobalt is also found in a blue clay along with native silver, in ores of bismuth, and in the mineral called *kupfernickel*. See NICKEL.

The *essay* of cobalt is described at the article REGULUS *of Cobalt*.

SECT. XII. *Ores of Zinc.*

§ 1. THE proper ore of zinc is a substance which has rather an earthy or stony than metallic appearance, and is called *calamy*, *calamine*, or *lapis calaminaris*. This stone, although metallic, is but moderately heavy, and has not the brilliancy of most other ores. Its colour is yellow, and like that of rust. It is also less dense than other metallic minerals. It seems to be an ore naturally decomposed. The calamine is not worked directly to obtain zinc from it, because this would only succeed in close vessels, and consequently with small quantities, according to Mr Margraaf's process. But it is successfully employed for the conversion of copper into brass by cementation, by which the existence of zinc in that stone is sufficiently proved.

Mr Wallerius enumerates also amongst the ores of zinc a very compounded mineral, consisting of zinc, sulphur, iron, and arsenic. This mineral, called *blend*, resembles externally the ore of lead, and hence has been called *false galena*. These blends have different forms and colours; but are chiefly red, like the red ore of antimony.

Zinc is obtained from certain minerals in the East Indies, of which we know little.

Calciform ores of zinc, according to Cronstedt, are pure or mixed. The pure are indurated, and sometimes crystallised, resembling lead-spar. The mixed ore contains also some calx of iron. This is *calamine*. It is whitish, yellowish, reddish, or brown.

Zinc is *mineralised*, 1. By *sulphurated iron*. *Ore of zinc*. Wallerius says, lead is sometimes contained in this ore. It is white, blue, or brown. 2. By *sulphur, arsenic, and iron*. *Blend*, or *pseudo-galena*, or *false-galena*, or *black-jack*. These are of various colours, white, yellowish, brown, reddish, greenish, black. They consist of scales, or are tessellated. Mr Cronstedt thinks, that in blends the zinc is mineralised in the state of a calx, and in the ore of zinc in its metallic state.

§ 2. Although the minerals above enumerated have been known, from their property of converting copper into brass, to be ores of zinc, yet the method of essaying

Ores of Zinc.

faying them fo as to obtain the contained zinc was not known, or at leaft not publifhed, before Mr Margraaf's Memoir of the Berlin Academy for the year 1746, upon that fubject. That very able chemift has fhewn, that zinc may be obtained from its ores, from the flowers, or from any other calx of zinc, by treating thefe with charcoal-duft, in clofe veffels, to prevent the combuftion of the zinc, which happens immediately upon its reduction when expofed to air. For this purpofe, he put a quantity of finely powdered calamine, or roafted blend, or other calx of zinc, well mixed with an eighth part of charcoal-duft, into a ftrong, luted earthen retort, to which he fitted a receiver. Having placed his retort in a furnace and raifed the fire, he applied a violent heat during two hours. When the veffels were cold and broken, he found the zinc in its metallic form adhering to the neck of the retort.

The chief difficulty in this operation is to get an earthen retort fufficiently compact to retain the vapour of the zinc, (for it eafily pervades the Heffian crucibles, Stourbridge melting-pots, and fimilar veffels, as may be feen from the quantity of flowers which appear upon their outer furface, when zinc or its calxes and any inflammable matter have been expofed to heat within thefe veffels) and at the fame time fufficiently ftrong to refift the violent fire which Mr Margraaf requires.

A pretty exact effay of an ore of zinc may be made in the following manner.

Mix a quantity of pulverifed roafted ore or calx of zinc with an eighth part of charcoal-duft. Put this mixture into a crucible capable of containing thrice the quantity. Diffufe equally amongft this mixture a quantity of fmall grains or thin plates of copper equal to that of the calamine or ore employed, and upon the whole lay another equal quantity of grains or plates of copper; and laftly, cover this latter portion of copper with charcoal-duft. Lute a lid upon the crucible; and apply a red heat during an hour or two. The copper or part of it will unite with the vapour of the zinc, and be thereby converted into brafs. By comparing the weight of all the metal after the operation, with the weight of the copper employed; the weight acquired, and confequently the quantity of zinc united with the copper, will be known. The copper which has not been converted into brafs, or more copper with frefh charcoal-duft, may be again added in the fame manner to the remaining ore, and the operation repeated with a heat fomewhat more intenfe, that any zinc remaining in the ore may be thus extracted. A curious circumftance is, that a much greater heat is required to obtain zinc from its ore, by diftillation, than in the operation now defcribed of making brafs; in which the feparation of the zinc from its ore feems to be facilitated by its difpofition to unite with copper.

Sect. XIII. *Ores of Arfenic.*

Ores of Arfenic.

§ 1. The minerals which contain the largeft quantity of arfenic are cobalts and white pyrites; although it is alfo contained in other ores, it being one of the mineralifing fubftances. But as cobalt muft be roafted to obtain the fulphur it contains, the arfenic alfo which rifes during this torrefaction is collected, as we fhall fee in Part III. (Smelting of Ores,) and the particular articles of each of the metallic fubftances mentioned in this article.

I. Regulus of arfenic is found native. It is of a leaden colour; it burns with a fmall flame; and is diffipated, leaving generally a very fmall quantity of calx of bifmuth, or of calx of cobalt, and a very little filver. When it is of a folid and teftaceous texture, it has been improperly called *teftaceous cobalt*, in German *fcherbencobalt*. II. Calx of arfenic is found in form of powder; native flowers of arfenic, or of indurated femitranfparent cryftals; native cryftalline arfenic. III. Calx of arfenic is mixed, 1. With fulphur: when yellow, it is called *orpiment;* when red, it is called *native realgar:* the difference of colour depends on the proportion of the two component parts. 2. With calx of tin; tin-grains. 3. With fulphur and filver, in the red filver ore. 4. With calx of lead, in the lead-fpar. 5. With calx of cobalt, in the efflorefcence of cobalt. IV. Arfenic is mineralifed, 1. With fulphurated iron; arfenical pyrites. 2. With iron only; white pyrites, or mifspickle. 3. With cobalt, in almoft all cobalt-ores. 4. With filver. 5. With copper. 6. With antimony.

§ 2. Arfenic may be feparated from its ore or earthy matter with which it happens to be mixed, by fublimation, according to the following procefs by Mr Cramer.

"Do every thing as was faid about mercury, or fulphur; but let the veffel which is put into the fire with the ore in it be of earth or ftone, and the recipient be of glafs, and of a middling capacity. Nor is it neceffary that this fhould be filled with water, fo it be but well luted. The fire muft likewife be ftronger, and continued longer than for the extracting of fulphur. Neverthelefs every kind of arfenic cannot be extracted in a confined fire: for it adheres to the matrix more ftrongly than fulphur and mercury. You will find in the part of the veffel which is more remote from the fire, pulverulent and fubtle flowers of arfenic; but there will adhere to the pofterior of the neck of the retort fmall folid maffes, fhining like fmall cryftals, tranfparent, fometimes gathered into a folid fublimate, and perfectly white, if the ore of the arfenic was perfectly pure; which, neverthelefs, happens very feldom. The flowers are moft commonly thin, and of a grey colour: which proceeds from the phlogifton mixed with the mafs. They are often of a citron or of a golden colour, which is a fign that there is in the mixture fome mineral fulphur; and if the fublimate be red or yellow, it is a fign of much fulphur.

"As all the arfenic contained in the ore is not expelled in clofe veffels, you muft weigh the refiduum; then roaft it in a crucible till it fmokes no longer, or rather in an earthen flat veffel not glazed, and in a ftrong fire to be ftirred now and then with a poker, and then weigh it when grown cold: you will be able thus to know how much arfenic remained in the clofe veffel, unlefs the ore contain bifmuth."

If the arfenic be fulphurated, it may be purified by triturating it with mercury or with fixed alkali, and by fubliming the arfenic from the remaining fulphurated mercury or alkali. The method of obtaining a regulus of arfenic is defcribed at the article Regulus *of Arfenic*.

PART III.

SMELTING OF ORES.

Sulphur-works.

HAVING ſhown the nature of the principal metallic minerals, and the ſubſtances of which they are compoſed; and alſo explained the proceſſes by which an exact analyſis of theſe compound minerals may be made, and the nature and quantity of the contained metals may be known; in order to complete what relates to this important ſubject, we ſhall deſcribe in this Part the principal operations by which metals, &c. are obtained "in the great," as it is called, or for commercial purpoſes. What we ſhall ſay upon this ſubject will chiefly be extracted from a *Treatiſe on the Smelting of Ores, by Schlutter*, tranſlated from the German into French by M. Hellot; becauſe this, of all the modern works upon that ſubject, appears to be the moſt exact. We ſhall firſt deſcribe the operations upon pyritous matters for the extraction of ſulphur, &c. and afterwards the operations by which metallic ſubſtances are extracted from *ores* properly ſo called.

SECT. I. *Extraction of Sulphur from Pyrites and other Minerals.*

IN order to obtain ſulphur from pyrites, this mineral ought to be expoſed to a heat ſufficient to ſublime the ſulphur, or to make it diſtill in veſſels, which muſt be cloſe, to prevent its burning.

Sulphur is extracted from pyrites at a work at Schwartzemberg, in Saxony, in the high country of the mines; and in Bohemia, at a place called *Alten-Sattel*.

The furnaces employed for this operation are oblong, like vaulted galleries; and in the vaulted roofs are made ſeveral openings. Theſe are called *furnaces for extracting ſulphur*.

In theſe furnaces are placed earthen-ware tubes, filled with pyrites broken into pieces of the ſize of ſmall nuts. Each of theſe tubes contains about 50 pounds of pyrites. They are placed in the furnace almoſt horizontally, and have ſcarcely more than an inch of deſcent. The ends, which come out of the furnace five or ſix inches, become gradually narrower. Within each tube is fixed a piece of baked earth, in form of a ſtar, at the place where it begins to become narrower, in order to prevent the pyrites from falling out, or choaking the mouth of the tube. To each tube is fitted a receiver, covered with a leaden plate, pierced with a ſmall hole to give air to the ſulphur. The other end of the tube is exactly cloſed. A moderate fire is made with wood, and in eight hours the ſulphur of the pyrites is found to have paſſed into the receivers.

The reſiduum of the pyrites, after the diſtillation, is drawn out at the large end, and freſh pyrites is put in its place. From this reſiduum, which is called *burnings of ſulphur*, vitriol is extracted.

The 11 tubes, into which were put, at three ſeveral diſtillations, in all nine quintals or 900 pounds of pyrites, yield from 100 to 150 pounds of crude ſulphur, which is ſo impure as to require to be purified by a ſecond diſtillation.

Sulphur-works.

This purification of crude ſulphur is alſo done in a furnace in form of a gallery, in which five iron cucurbits are arranged on each ſide. Theſe cucurbits are placed in a ſloping direction, and contain about eight quintals and a half of crude ſulphur. To them are luted earthen tubes, ſo diſpoſed as to anſwer the purpoſe of capitals. The noſe of each of theſe tubes is inſerted into an earthen pot called the *fore-runner*. This pot has three openings; namely, that which receives the noſe of the tube; a ſecond ſmaller hole, which is left open to give air; and a third in its lower-part, which is ſtopped with a wooden peg.

When the preparations are made, a fire is lighted about ſeven o'clock in the evening, and is a little abated as ſoon as the ſulphur begins to diſtil. At three o'clock in the morning, the wooden pegs which ſtop the lower holes of the fore-runners are for the firſt time drawn out, and the ſulphur flows out of each of them into an earthen pot with two handles, placed below for its reception. In this diſtillation the fire muſt be moderated and prudently conducted; otherwiſe leſs ſulphur would be obtained, and it alſo would be of a grey colour, and not of the fine yellow which it ought to have when pure. The ordinary loſs in the purification of eight quintals of crude ſulphur is, at moſt, one quintal.

When all the ſulphur has flowed out, and has cooled a little in the earthen pots, it is caſt into moulds made of beech-tree, which have been previouſly dipt in water and ſet to drain. As ſoon as the ſulphur is cooled in the moulds, they are opened, and the cylinders of ſulphur are taken out and put up in caſks. Theſe are called *roll-brimſtone*.

As ſulphur is not only in pyrites, but alſo in moſt metallic minerals, it is evident that it might be obtained by works in the great from the different ores which contain much of it, and from which it muſt be ſeparated previouſly to their fuſion: but as ſulphur is of little value, the trouble of collecting it from ores is ſeldom taken. Smelters are generally ſatisfied with freeing their ores from it, by expoſing them to a fire ſufficient to expel it. This operation is called *torrefaction*, or *roaſting of ores*.

There are, however, ores which contain ſo much ſulphur, that part of it is actually collected in the ordinary operation of roaſting, without much trouble for that purpoſe. Such is the ore of Ramelſberg in the country of Hartz.

This ore, which is of lead, containing ſilver, is partly very pure, and partly mixed with cupreous pyrites and ſilver; hence it is neceſſary to roaſt it.

The roaſting is performed by laying alternate ſtrata of ore and wood upon each other in an open field, taking care to diminiſh the ſize of the ſtrata as they riſe higher; ſo that the whole maſs ſhall be a quadrangular pyramid truncated above, whoſe baſe is about 31 feet ſquare. Below, ſome paſſages are left open, to give free entrance to the air; and the ſides and

and top of the pyramid are covered over with ſmall ore, to concentrate the heat and make it laſt longer. In the centre of this pyramid there is a channel which deſcends vertically from the top to the baſe. When all is properly arranged, ladlefuls of red-hot ſcoria from the ſmelting-furnace are thrown down the channel, by which means the ſhrubs and wood placed below for that purpoſe are kindled, and the fire is from them communicated to all the wood of the pile, which continues burning till the third day. At that time the ſulphur of the mineral becomes capable of burning ſpontaneouſly, and of continuing the fire after the wood is conſumed.

When this roaſting has been continued 15 days, the mineral becomes greaſy; that is, it is covered over with a kind of varniſh: 20 or 25 holes or hollows are then made in the upper-part of the pile in which the ſulphur is collected. From theſe cavities the ſulphur is taken out thrice every day, and thrown into water. This ſulphur is not pure, but crude; and is therefore ſent to the manufacturers of ſulphur, to be purified in the manner above-related.

As this ore of Ramelſberg is very ſulphureous, the firſt roaſting, which we are now deſcribing, laſts three months; and during this time, if much rain has not fallen, or if the operation has not failed by the pile falling down or cracking, by which the air has ſo much free acceſs, that the ſulphur is burnt and conſumed, from 10 to 20 quintals of crude ſulphur are by this method collected.

The ſulphur of this ore, like that of moſt others, was formerly neglected, till, in the year 1570, a perſon employed in the mines called *Chriſtopher Sauder*, diſcovered the method of collecting it, nearly as it is done at preſent.

Metallic minerals are not the only ſubſtances from which ſulphur is extracted. This matter is diffuſed in the earth in ſuch quantities, that the metals cannot abſorb it all. Some ſulphur is found quite pure, and in different forms, principally in the neighbourhood of volcanos, in caverns, and in mineral waters. Such are the opaque kind called *virgin ſulphur;* the tranſparent kind called *ſulphur of Quito;* and the native flowers of ſulphur, as thoſe of the waters of Aix-la-Chapelle. It is alſo found mixed with different earths. Here we may obſerve, that all thoſe kinds of ſulphur which are not mineralized by metallic ſubſtances, are found near volcanoes, or hot mineral waters, and conſequently in places where nature ſeems to have formed great ſubterranean laboratories, in which ſulphureous minerals may be analyſed and decompoſed, and the ſulphur ſeparated, in the manner in which it is done in ſmall in our works and laboratories. However that be, certainly one of the beſt and moſt famous ſulphur-mines in the world is that called *Solfatara.* The Abbé Nollet has publiſhed, in the Memoirs of the Academy, ſome intereſting obſervations upon this ſubject, which we ſhall here abridge.

Near Puzzoli, in Italy, is that great and famous mine of ſulphur and alum called at preſent *Solfatara.* It is a ſmall oval plain, the greateſt diameter of which is about 400 yards, raiſed about 300 yards above the level of the ſea. It is ſurrounded by high hills and great rocks, which fall to pieces, and whoſe fragments form very ſteep banks. Almoſt all the ground is bare and white, like marle; and is every-where ſenſibly warmer than the atmoſphere in the greateſt heat of ſummer, ſo that the feet of perſons walking there are burnt through their ſhoes. It is impoſſible not to obſerve the ſulphur there; for every-where may be perceived by the ſmell a ſulphureous vapour, which riſes to a conſiderable height, and gives reaſon to believe that there is a ſubterraneous fire below, from which that vapour proceeds.

Near the middle of this field there is a kind of baſon three or four feet lower than the reſt of the plain, in which a ſound may be perceived when a perſon walks on it, as if there were under his feet ſome great cavity, the roof of which was very thin. After that, the lake Agnano is perceived, whoſe waters ſeem to boil. Theſe waters are indeed hot, but not ſo hot as boiling water. This kind of ebullition proceeds from vapours which riſe from the bottom of the lake, which being ſet in motion by the action of ſubterranean fires, have force enough to raiſe all that maſs of water. Near this lake there are pits, not very deep, from which ſulphureous vapours are exhaled. Perſons who have the itch, come to theſe pits, and receive the vapours in order to be cured. Finally, there are ſome deeper excavations, whence a ſoft ſtone is procured which yields ſulphur. From theſe cavities vapours exhale, and iſſue out with noiſe, and which are nothing elſe than ſulphur ſubliming through the crevices. This ſulphur adheres to the ſides of the rocks, where it forms enormous maſſes: in calm weather, the vapours may be evidently ſeen to riſe 25 or 30 feet from the ſurface of the earth.

Theſe vapours, attaching themſelves to the ſides of rocks, form enormous groups of ſulphur, which ſometimes fall down by their own weight, and render theſe places of dangerous acceſs.

In entering the Solfatara, there are warehouſes and buildings erected for the refining of ſulphur.

Under a great ſhed, or hangar, ſupported by a wall behind, and open on the other three ſides, the ſulphur is procured by diſtillation from the ſoft ſtones we mentioned above. Theſe ſtones are dug from under ground; and thoſe which lie on the ſurface of the earth are neglected. Theſe laſt are, however, covered with a ſulphur ready formed, and of a yellow colour: but the workmen ſay they have loſt their ſtrength, and that the ſulphur obtained from them is not of ſo good a quality as the ſulphur obtained from the ſtones which are dug out of the ground.

Theſe laſt mentioned are broken into lumps, and put into pots of earthen ware, containing each about 20 pints Paris meaſure. The mouths of theſe pots are as wide as their bottoms; but their bellies, or middle parts, are wider. They are covered with a lid of the ſame earth, well luted, and are arranged in two parallel lines along two brick walls, which form the two ſides of a furnace. The pots are placed within theſe walls; ſo that the centre of each pot is in the centre of the thickneſs of the wall, and that one end of the pots overhangs the wall within, while the other end overhangs the wall without. In each furnace ten of theſe pots are placed; that is, five in each of the two walls which form the two ſides of the furnace. Be-

twixt

twixt thefe walls there is a fpace of 15 or 18 inches; which fpace is covered by a vault refting on the two walls. The whole forms a furnace feven feet long, two feet and a half high, open at one end, and fhut at the other, excepting a fmall chimney through which the fmoke paffes.

Each of thefe pots has a mouth in its upper part without the furnace, in order to admit a tube of 18 lines in diameter and a foot in length, which communicates with another pot of the fame fize placed without the building, and pierced with a round hole in its bafe of 15 or 18 lines diameter. Laftly, to each of thefe laft-mentioned pots there is a wooden tub placed below, in a bench made for that purpofe.

Four or five of thefe furnaces are built under one hangar, or fhed. Fires are kindled in each of them at the fame time; and they are thrown down after each diftillation, either that the pots may be renewed, or that the refiduums may be more eafily taken out.

The fire being kindled in the furnace, heats the firft pots containing the fulphureous ftones. The fulphur rifes in fumes into the upper part of the pot, whence it paffes through the pipe of communication into the external veffel. There the vapours are condenfed, become liquid, and flow through the hole below into the tub, from which the fulphur is eafily turned out, becaufe the form of the veffel is that of a truncated cone whofe narrower end is placed below, and becaufe the hoops of the tub are fo faftened that they may be occafionally loofened. The mafs of fulphur is then carried to the buildings mentioned before, where it is remelted for its purification, and caft into rolls, fuch as we receive it.

Extraction of Vitriol *from pyrites.* See Chemistry, n° 110, 142, 157.

Extraction of Alum *from pyritous fubftances and from aluminous earths.* See Chemistry, n° 129.

Sect. II. *Smelting of Ores in general.*

§ 1. As ores confift of metallic matters combined with fulphur and arfenic, and are befides intermixed with earthy and ftony fubftances of all kinds, the intention of all the operations upon thefe compound bodies is to feparate thefe different fubftances from each other. This is effected by feveral operations founded on the known properties of thofe fubftances. We now proceed to give a general idea of thefe feveral operations.

Firft of all, the ore is to be feparated from the earths and ftones accidentally adherent to it; and when thefe foreign fubftances are in large maffes, and are not very intimately mixed in fmall particles with the ore, this feparation may be accomplifhed by mechanical means. This ought always to be the firft operation, unlefs the adherent fubftance be capable of ferving as a flux to the ore. If the unmetallic earths be intimately mixed with the ore, this muft neceffarily be broken and divided into fmall particles. This operation is performed by a machine which moves peftles, called *bocards* or *ftampers*. After this operation, when the parts of the mineral are fpecifically heavier than thofe of the unmetallic earth or ftone, thefe latter may be feparated from the ore by wafhing in canals through which water flows. With regard to this wafhing of ores, it is neceffary to obferve, that it cannot fucceed but when the ore is fenfibly heavier than the foreign matters. But the contrary happens frequently, as well becaufe quartz and fpar are naturally very ponderous, as becaufe the metallic matter is proportionably fo much lighter as it is combined with more fulphur.

When an ore happens to be of this kind, it is neceffary to begin by roafting it, in order to deprive it of the greateft part of its fulphur.

It happens frequently that the pyritous matters accompanying the ore are fo hard that they can fcarcely be pounded. In this cafe it is neceffary to roaft it entirely, or partly, and to throw it red-hot into cold water; by which the ftones are fplit, and rendered much more capable of being pulverized.

Thus it happens very frequently, that roafting is the firft operation to which an ore is expofed.

When the fubftance of the ore is very fufible, this firft operation may be difpenfed with, and the matter may be immediately fufed without any previous roafting, or at leaft with a very flight one. For, to effect this fufion, it is neceffary that it retain a great quantity of its fulphur, which, with the other fluxes added, ferves to deftroy or convert into fcoria a confiderable part of the ftony matter of the mineral, and to reduce the reft into a brittle fubftance, which is called the *matt of lead*, or of *copper*, or other metal contained in the ore. This matt is therefore an intermediate matter betwixt the mineral and the metal; for the metal is there concentrated, and mixed with lefs ufelefs matter than it was in the ore. But as this matt is always fulphureous, the metal which it contains cannot have its metallic properties. Therefore it muft be roafted feveral times to evaporate the fulphur, before it is remelted, when the pure metal is required. This fufion of an ore not roafted, or but flightly roafted, is called *crude fufion.*

We may here obferve upon the fubject of wafhing and roafting of ores, that as arfenic is heavier than fulphur, and has nearly the weight of metals, the ores in which it prevails are generally very heavy, and confequently are fufceptible of being wafhed, which is a great advantage. But on the other fide, as arfenic is capable of volatilifing, fcorifying, and deftroying many metals, thefe ores have difadvantages in the roafting and fufion, in both which confiderable lofs is caufed by the arfenic. Some ores contain, befides arfenic, other volatile femi-metals, fuch as antimony and zinc. Thefe are almoft untractable, and are therefore neglected. They are called *mineræ rapaces*, "rapacious ores."

When the metal has been freed as much as is poffible from foreign matters by thefe preliminary operations, it is to be completely purified by fufions more or lefs frequently repeated; in which proper additions are made, either to abforb the reft of the fulphur and arfenic, or to complete the vitrification or fcorification of the unmetallic ftones and earth.

Laftly, as ores frequently contain feveral different metals, thefe are to be feparated from each other by proceffes fuited to the properties of thefe metals, of which we fhall fpeak more particularly as we proceed in our examination of the ores of each metal.

§ 2. To facilitate the extraction of metallic fubftances from the ores and minerals containing them, fome operations previous to the fufion or fmelting of thefe

Roasting of Ores.

these ores and minerals are generally neceſſary. These operations conſiſt of, 1. The *ſeparation* of the ores and metallic matters from the adhering unmetallic earths and ſtones, by hammers and other mechanical inſtruments, and by waſhing with water. 2. Their *diviſion* or reduction into ſmaller parts by contuſion and trituration, that by another waſhing with water they may be more perfectly cleanſed from extraneous matters, and rendered fitter for the ſubſequent operations, calcination or roaſting, and fuſion. 3. *Roaſting* or *calcination;* the uſes of which operation are, to expel the volatile, uſeleſs, or noxious ſubſtances, as water, vitriolic acid, ſulphur, and arſenic; to render the ore more friable, and fitter for the ſubſequent contuſion and fuſion; and, laſtly, to calcine and deſtroy the viler metals, for inſtance the iron of copper-ores, by means of the fire, and of the ſulphur and arſenic. Stones, as quartz and flints, containing metallic veins or particles, are frequently made red-hot, and then extinguiſhed in cold water, that they may be rendered ſufficiently friable and pulverable, to allow the ſeparation of the metallic particles.

Roaſting is unneceſſary for native metals; for ſome of the richer gold and ſilver ores; for ſome lead-ores, the ſulphur of which may be ſeparated during the fuſion; and for many calciform ores, as theſe do not generally contain any ſulphur and arſenic.

In the roaſting of ores, the following attentions muſt be given, 1. To reduce the mineral previouſly into ſmall lumps, that the ſurface may be increaſed; but they muſt not be ſo ſmall, nor placed ſo compactly, as to prevent the paſſage of the air and flame. 2. The larger pieces muſt be placed at the bottom of the pile, where the greateſt heat is. 3. The heat muſt be gradually applied, that the ſulphur may not be melted, which would greatly retard its expulſion; and that the ſpars, fluors, and ſtones, intermixed with the ore, may not crack, fly, and be diſperſed. 4. The ores not thoroughly roaſted by one operation muſt be expoſed to a ſecond. 5. The fire may be increaſed towards the end, that the noxious matters more ſtrongly adhering may be expelled. 6. Fuel which yields much flame, as wood and foſſil coals free from ſulphur, is ſaid to be preferable to charcoal or coaks. Sometimes cold water is thrown on the calcined ore at the end of the operation, while the ore is yet hot, to render it more friable.

No general rule can be given concerning the duration or degree of the fire, theſe being very various according to the difference of the ores. A roaſting during a few hours or days is ſufficient for many ores; while ſome, ſuch as the ore of Rammelſberg, require that it ſhould be continued during ſeveral months.

Schlutter enumerates five methods of roaſting ores. 1. By conſtructing a pile of ores and fuel placed in alternate ſtrata, in the open air, without any furnace. 2. By confining ſuch a pile within walls, but without a roof. 3. By placing the pile under a roof, without lateral walls. 4. By placing the pile in a furnace conſiſting of walls and a roof. 5. By roaſting the ore in a reverberatory furnace, in which it muſt be continually ſtirred with an iron rod.

Several kinds of fuſions of ores may be diſtinguiſhed. 1. When a ſulphureous ore is mixed with much earthy matter, from which it cannot be eaſily ſeparated by mechanical operations, it is frequently melted, in order to diſengage it from theſe earthy matters, and to concentrate its metallic contents. By this fuſion, ſome of the ſulphur is diſſipated, and the ore is reduced to a ſtate intermediate betwixt that of ore and of metal. It is then called a *matt (lapis ſulphureo-metallicus);* and is to be afterwards treated like a pure ore by the ſecond kind of fuſion, which is properly the ſmelting, or extraction of the metal by fuſion. 2. By this fuſion or ſmelting, the metal is extracted from the ore previouſly prepared by the above operations, if theſe be neceſſary. The ores of ſome very fuſible metals, as of biſmuth, may be ſmelted by applying a heat ſufficient only to melt the metals, which are thereby ſeparated from the adhering extraneous matters. This ſeparation of metals by fuſion, without the vitrification of extraneous matters, may be called *eliquation*. Generally, a complete fuſion of the ore and vitrification of the earthy matters are neceſſary for the perfect ſeparation of the contained metals. By this method, metals are obtained from their ores, ſometimes pure, and ſometimes mixed with other metallic ſubſtances, from which they muſt be afterwards ſeparated; as we ſhall ſee, when we treat of the extraction of particular metals. To procure this ſeparation of metals from ores, theſe muſt be ſo thinly liquefied, that the ſmall metallic particles may diſengage themſelves from the ſcoria; but it muſt not be ſo thin as to allow the metal to precipitate before it be perfectly diſengaged from any adhering extraneous matter, or to pervade and deſtroy the containing veſſels and furnace. Some ores are ſufficiently fuſible; but others require certain additions called *fluxes*, to promote their fuſion and the vitrification of their unmetallic parts; and alſo to render the ſcoria ſufficiently thin to allow the ſeparation of the metallic particles.

Fuſion of Ores.

Different fluxes are ſuitable to different ores, according to the quality of the ore, and of the matrix, or ſtone adherent to it.

The matrixes of two different ores of the ſame metal frequently ſerve as fluxes to each other; as, for inſtance, an argillaceous matrix with one that is calcareous; theſe two earths being diſpoſed to vitrification when mixed, though each of them is ſingly unfuſible. For this reaſon, two or more different ores to be ſmelted are frequently mixed together.

The ores alſo of different metals require different fluxes. Thus calcareous earth is found to be beſt ſuited to iron-ores, and ſpars and ſcoria to fuſible ores of copper.

The fluxes moſt frequently employed in the ſmelting of ores are, calcareous earth, fluors or vitreous ſpars, quartz and ſand, fuſible ſtones, as ſlates, baſaltes, the ſeveral kinds of ſcoria, and pyrites.

Calcareous earth is uſed to facilitate the fuſion of ores of iron, and of ſome of the poorer ores of copper, and, in general, of ores mixed with argillaceous earths, or with feltſpar. This earth has been ſometimes added with a view of ſeparating the ſulphur, to which it very readily unites: but by this union the ſulphur is detained, and a hepar is formed, which readily diſſolves iron and other metals, and ſo firmly adheres to them, that they cannot be ſeparated without more difficulty than they could from the original ore. This addition is therefore not to be made till the ſulphur be previ-ouſly

Of Fluors. ously well expelled.

Fluors or *fusible spars* facilitate the fusion of most metallic minerals, and also of calcareous and argillaceous earths, of steatites, asbestus, and some other unfusible stones, but not of siliceous earths without a mixture of calcareous earth.

Quartz is sometimes added in the fusion of ferruginous copper ores, the use of which is said chiefly to be, to enable the ore to receive a greater heat, and to give a more perfect vitrification to the ferruginous scoria.

The *fusible stones*, as *slates*, *basaltes*, are so tenacious and thick when fused, that they cannot be considered properly as fluxes, but as matters added to lessen the too great liquidity of some very fusible minerals.

The *scoria* obtained in the fusion of an ore is frequently useful to facilitate the fusion of an ore of the same metal, and sometimes even of ores of other metals.

Sulphurated pyrites greatly promote the fusibility of the scoria of metals, from the sulphur it contains. It is chiefly added to difficultly-fusible copper-ores, to form the sulphureous compounds called *matts*, that the ores thus brought into fusion may be separated from the adhering earthy matters, and that the ferruginous matter contained in them may be destroyed, during the subsequent calcination and fusion, by means of the sulphur.

As in the ores called *calciform*, the metallic matter exists in a calcined state; and as calcination reduces the metals of mineralized ores (excepting the perfect metals) to that state also; therefore all calciform and calcined ores require the addition of some inflammable substance, to reduce them to a metallic state. In great works, the charcoal or other fuel used to maintain the fire produces also this effect.

Metals are sometimes added in the fusion of ores of other more valuable metals, to absorb from these sulphur or arsenic. Thus iron is added to sulphurated, cupreous, and silver ores. Metals are also added in the fusion of ores of other more valuable metals, to unite with and collect the small particles of these dispersed through much earthy matter, and thus to assist their precipitation. With these intentions, lead is frequently added to ores and minerals containing gold, silver, or copper.

Ores of metals are also sometimes added to assist the precipitation of more valuable metals. Thus antimony is frequently added to assist the precipitation of gold intermixed with other metallic matters. Thus far of smelting of ores in general.

Sect. III. *Operations on Ores of Native Gold and Silver, by Washing and by Mercury.*

Earths and sand are at first separated by washing with water; by which operation the greatest part of what is not gold, being lighter, is carried off. After this a second washing is made with mercury, which having the property of uniting with gold, seizes this metal, amalgamates with it, and separates it exactly from the earthy matters, with all which it can form no union.

The mercury thus charged with gold is pressed through shamoy leather, and the gold is retained united with a part of the mercury, from which it may be easily disengaged by exposure to a proper degree of heat, which dissipates and evaporates the mercury, while the gold, being fixed, remains.

Washing of Ores of Gold.

This is the foundation of all the operations by which gold is obtained from the rich mines of Peru belonging to the Spaniards. These operations consist in washings, triturations, and amalgams in the great by help of machines.

The ores of native silver are much rarer and less abundant than those of gold. But if any of this kind were found sufficiently rich, they might be treated with mercury exactly in the same manner as the ores of native gold.

Gold is frequently contained in the ores of other metals, either in a native or mineralised state, and in sands, especially those which are black and ferruginous. See Part II. sect. of *Ores of Gold.*

If *gold be contained in ores of other metals*, these metals together with the gold may be first extracted by the ordinary processes for smelting these ores; and the gold may be then separated from the metallic mass thus obtained, by mixing and fusing this mass with a quantity of lead, and by the process of cupellation described in the articles Essay *of the value of silver*, and Refining. Generally, the operations for obtaining gold from ores of imperfect metals are precisely the same as those for obtaining silver, to which therefore we refer. Most frequently a quantity of silver also is contained in these ores; and in this case the perfect metal obtained by cupellation is an allay of gold and silver, which must be afterwards separated by the processes called *parting*. See Parting.

Many trials have been made to procure the small quantity of gold contained in the *ferruginous sands*, at a moderate expence (see Part II. sect. of *Ores of Gold*); but as no work of this kind is now established, we may presume they have not been successful. The best essays of this kind have been made, according to Schlutter, in the following manner.

The sand is to be made red-hot, and extinguished in cold water four times, by which its colour is changed from the original yellow, red, or black, to a reddish-brown. It is observed to emit, during the first and second calcinations, an arsenical smell; and this smell may be produced again in the following calcinations by adding some inflammable matter. Let an ounce of the calcined sand be mixed with two ounces of granulated lead, and one ounce of black flux, and put into a Hessian crucible, with half an ounce of decrepitated sea-salt upon the surface of the mixture. The crucible is to be placed in a good blast-furnace, and a strong fire is to be excited. The matter contained in the crucible is to be frequently stirred with an iron-rod, and the heat is to be continued till the scoria is thin and perfectly fused. When the crucible is broken, a regulus of lead will be found, containing the gold and silver of the sand. By this method Mr Leberecht obtained, in eleven essays, from 840 to 844 grains of perfect metal from a quintal of sand. Of the perfect metal obtained, from a fourth to a third part was gold. Some parcels of sand have yielded more than 1000 grains, and some not more than 350 grains, per quintal. Instead of the granulated lead, and the black flux, which is too expensive for great operations, some have added, to an ounce of the sand, two ounces of litharge and

and a little powder of charcoal, by which they have obtained the fame quantity of perfect metal. The fcoria in thefe effays has been always found to contain fome perfect metal.

The Hungarian copper ores, from which gold and filver are profitably extracted, contain a lefs quantity of thefe perfect metals than many ferruginous fands. But they may be formed into a matt, by fufion with pyrites, of which treatment the fands are incapable. From this matt, the gold and filver, along with the copper of the ore, may be precipitated, and feparated from the fulphur of the pyrites, by addition of iron, which being more difpofed than the other metals to unite with fulphur, difengages thefe metals, and allows them to precipitate.

Sect. IV. *Smelting of Ores of Silver.*

§ 1. As filver, even in its proper ores, is always allayed with fome other metals from which it is intended to be feparated after that the filver-ore has been well roafted, it muft be mixed with a greater or lefs quantity of lead previous to its fufion.

Lead has the fame effect in fufion of gold and filver as mercury has upon thefe metals by its natural fluidity; that is to fay, it unites with them, and feparates them from unmetallic matters, which, being lighter, rife always to the furface. But lead has the further advantage of procuring, by its own vitrification, that of all metallic fubftances, excepting gold and filver. Hence it follows, that when gold and filver are obtained by means of mercury, they ftill remain allayed with other metallic fubftances; whereas when they are obtained by fufion and fcorification with lead, they are then pure, and not allayed with any metals but with each other.

In proportion as the lead, which has been united to the gold and filver of the ore, is fcorified by the action of the fire, and promotes the fcorification of the other metallic matters, it feparates the perfect metals, and carries with it all the others to the furface. There it meets the unmetallic fubftances, which it likewife vitrifies, and which it changes into a perfect fcoria, fluid, and fuch as a fcoria ought to be to admit all the perfect metal contained in it to precipitate.

When all heterogeneous matters have been thus difengaged by fcorification with lead, the perfect metals, to which fome lead ftill remains united, are to be further purified by the ordinary operation of the cupel.

The common rule for the fufion and fcorification of filver-ore with lead, is to add to the ore a quantity of lead fo much greater as there is more matter to be fcorified, and as thefe matters are more refractory and of more difficult fufion. Silver ores, or thofe treated as fuch, are often rendered refractory by ferruginous earths, pyritous matters, or cobalts, containing always a confiderable quantity of an earth which is unmetallic, very fubtile, and very refractory, and which renders a confiderable augmentation of the quantity of lead neceffary.

The quantity of lead which is commonly added to fufible filver ores, that do not contain lead, is eight times the quantity of the ore. But when the ore is refractory, it is neceffary to add twelve times the quantity of lead, and even more; alfo glafs of lead, and fluxes, fuch as the white and black fluxes; to which however borax and powder of charcoal are preferable, on account of the liver of fulphur formed by thefe alkaline fluxes.

It is neceffary to obferve, that faline fluxes are only ufed in fmall operations, on account of their dearnefs. To thefe are fubftituted, in the great operations, of which we now treat, fandiver, fufible fcoria, and other matters of little value.

The greateft part of filver now employed in commerce is not obtained from the proper ores of filver, which are very fcarce; but from lead, and even copper ores, which are more or lefs rich in filver. To give an idea of the manner of treating thefe kinds of ores, from which filver is extracted in the great works, we fhall briefly defcribe here, after Schlutter, the fmelting of the ore of Rammelfberg, which contains, as we have already faid, feveral different kinds of metals, but particularly lead and filver.

When this mineral has been difengaged from its fulphur as much as poffible by three very long roaftings, it is melted in the Lower Hartz in Saxony, in a particular kind of furnace, called a *furnace for fmelting upon a hollow or caffe*. The mafonry of this furnace is compofed of large thick flates, capable of fuftaining great heat, and cemented together by clay. The interior part of the furnace is three feet and a half long, and two feet broad at the back part, and one foot only in the front. Its height is nine feet eight inches. It has a foundation of mafonry in the ground; and in this foundation channels are made for the evaporation of the moifture. Thefe channels are covered over with ftones called *covering ftones*. The hollow or caffe, which is made above thefe, is formed of bricks, upon which are placed, firft, a bed of clay; then a bed of fmall ore and fifted vitriols; and, laftly, a bed of charcoal-powder beat down, called *light brafque*. The anterior wall of the furnace is thinner than the others, and is called the *chemife*. The back wall, which is pierced to give paffage to the pipes of two large wooden bellows, is called the *middle wall*. When the furnace is thus prepared, charcoal is thrown into the hollow, or caffe; which being kindled, the fire is to be continued during three hours, before the matters to be fufed are added. Then thefe matters are thrown in, which are not the pure ore, but a mixture of feveral fubftances, all of which are fomewhat profitable. The quantity of thefe matters is fufficient for one day's work; that is, for a fufion of eighteen hours; and it confifts of, 1. Twelve fchorbens or meafures of well roafted Rammelfberg ore; (the fchorben is a meafure whofe contents are two feet five inches long, one foot feven inches broad, and a little more than a foot deep: it is equal to 32 quintals of that country, Cologn weight, at 123 pounds each quintal.) 2. Six meafures of fcoria produced by the fmelting of the ore of Upper Hartz, which is refractory, and what workmen call *cold*. 3. Two meafures of knobben, which is an impure fcoria containing fome lead and filver, which has been formerly thrown away as ufelefs, and is now collected by women and children. Befides thefe, other matters are added, containing lead and filver, as the tefts employed in refining, the drofs of lead, impure litharge, and

Smelting of Ores of Silver.

and any rubbiſh containing metal, which was left in the furnace after the foregoing fuſion. All theſe matters being mixed together, are thrown into the furnace: and to each meaſure of this mixture a meaſure of charcoal is added. The fuſion is then begun by help of bellows; and as it proceeds, the lead falls through the light braſque, or charcoal-bed, into the hollow, or caſſe, where it is preſerved from burning under the powder of charcoal. The ſcoria, on the other hand, being lighter and leſs fluid, is ſkimmed off from time to time by means of ladles, that it may not prevent the reſt of the lead from falling down into the hollow. Thus, while the fuſion laſts, freſh matters and freſh charcoal are alternately added, till the whole quantity intended for one fuſion, or, as they call it, one *day*, be thrown in.

There are ſeveral eſſential things to be remarked in this operation, which is very well contrived. Firſt, The mixture of matters from which a little lead and ſilver is procured, which would otherwiſe be loſt; and which have alſo this advantage, that they retard the fuſion of the Ramelſberg ore, which, however well roaſted it has been, retains always enough of the ſulphur and iron of the pyrites mixed with it, to render it too fuſible or too fluid, ſo that without the addition of thoſe matters nothing would be obtained but a matt. It is even neceſſary, notwithſtanding theſe additions, not to haſten the fuſion too much, but to give time for the ore to mix with other matters, elſe it would melt and flow of itſelf before the reſt. Secondly, The fuſion of the ore through charcoal, which is practiſed in moſt ſmelting-houſes, and for almoſt all ores, is an excellent method, the principal advantage of which is the ſaving of fuel. The action of the burning charcoal directed immediately upon the mineral, at the ſame time that it melts it more readily and efficacioully, alſo ſupplies it with the phlogiſton neceſſary to bring it to a perfect ſtate.

From the Ramelſberg ore after its firſt roaſting, a *white vitriol* is obtained and prepared at Goſlar *, whoſe baſis was *zinc:* which proves that this ore contains alſo a certain quantity of this ſemi-metal. As this ore is ſmelted in a country where the art is well underſtood of extracting every thing which a mineral contains, ſo in this fuſion *zinc* and *cadmia* are obtained in the following manner: When the furnace is prepared for the fuſion, it is neceſſary to cloſe it up in the fore-part, before the fuſion is begun.

* See *Chemiſtry*, n° 157.

"Firſt of all, a gritt-ſtone is to be placed, ſupported at the height of three inches. This ſtone is as long as the furnace is broad, and the height of it is level with the hole where the bellows-pipe enters. It is faſtened on each ſide of the furnace, externally and internally, with clay. Upon this ſtone a kind of receptacle, or, as it is called, the *ſeat of the zinc*, is made in the following manner: A flat ſlaty ſtone is choſen, as long as the furnace is broad, and eight inches in breadth. This is placed on the gritt-ſtone above-mentioned, in ſuch a manner that it inclines conſiderably towards the front of the furnace, and that its bottom touches cloſely the gritt-ſtone. It is faſtened with clay, which is alſo laid upon the ſeat of the zinc. Upon this ſeat, which is to receive the zinc, two round pieces of charcoal are placed, and alſo a ſtone called the *zinc ſtone*, which is about a foot and a half in length, and cloſes one part of the front of the furnace. This ſtone alſo is faſtened on each of its ſides with clay. Clay is likewiſe put under the ſtone betwixt the two pieces of charcoal, which hinder it from touching the ſeat of the zinc. The under-part of this ſtone is but ſlightly luted, that the workmen may make an opening for the zinc to flow out. Thus is made the ſeat or receptacle of the zinc to detain this metallic ſubſtance, which would otherwiſe fall into the hotteſt part of the fire, called by the workmen the *melting-place*, and would be there burnt: whereas it is collected upon this receptacle during the fuſion, where it is ſheltered from the action of the bellows, and conſequently from too great heat.

"When all the matter to be fuſed in one day is put into the furnace, the blaſt of air is continued till that matter has ſunk down. When it is half-way down the furnace, they draw out the ſcoria, that more of the ore and other matters may be expoſed to the greateſt heat. As ſoon as the ſcoria is cooled and fixed a little, two ſhovel-fulls of ſmall wet ſcoria or ſand is thrown cloſe to the furnace, and beat down with the ſhovel; then the workmen open the ſeat or receptacle of zinc, and ſtrike upon the zinc-ſtone to make the ſemi-metal flow out. As ſoon as the pureſt part of it has flowed out, it is ſprinkled with water and carried away. Then the workmen ſeparate entirely the zinc-ſtone from the wall of the furnace, and they continue to give it little ſtrokes, that the ſmall particles of zinc diſperſed among the charcoal may fall down. This being done, the ſtone is removed; and the zinc is ſeparated from the charcoal by an iron inſtrument, is cleaned, and remelted along with the zinc that flowed out at firſt, and is caſt into round cakes. The reaſon why the zinc is withdrawn before the bellows ceaſe to blow, is, that if it was left till the charcoal on the ſeat or receptacle was conſumed, it would be moſtly burnt, and little would be obtained. Thus after the zinc is withdrawn, the fuſion is finiſhed by blowing the bellows till the end."

Thus the zinc is ſeparated from the ore of Ramelſberg, and is not confounded in the hollow or caſſe with the lead and ſilver, becauſe, being a volatile ſemi-metal, it cannot ſupport the activity of the fire without riſing into vapours, which are condenſed in the place leaſt hot, that is to ſay, upon the ſtones expreſsly prepared for that purpoſe; and which, being much thinner than the other walls of the furnace, are continually cooled by the external air.

It is alſo in this furnace, and after the fuſion of the Ramelſberg ore, that the *cadmia of zinc*, or the *cadmia of furnaces*, is obtained. This ore is compoſed of ſulphureous and ferruginous pyrites, of true lead-ore containing ſilver, and a very hard and compact matter of a dark browniſh-grey colour, which is probably a *lapis calaminaris*, or an ore of zinc. Theſe ſeveral matters of the Ramelſberg ore are not ſeparated from each other, either for the roaſting or for the fuſion. Thus there is zinc in all the parts of the roaſted ore; and much more of it would be obtained, if it was not ſo eaſily inflammable. All the zinc which is obtained is preſerved from burning by falling, while

Smelting of Ores of Silver.

while in fusion, behind the chemise or fore-part of the furnace, which is, as has been said, a kind of schistus or slate, called by the workmen *steel-stone*. But the part of this semi-metal which falls in the middle of the furnace, near the middle-wall, or towards the sides, being exposed to the greatest heat of the fire, is there burnt; and its smoke or flowers attaching itself on all sides to the walls of the furnace, undergo there a semi-fusion, which renders this matter so hard and so thick, that it must be taken away after every fourth fusion, or, at most, after every sixth fusion. That which is found attached to the highest part of the furnace is the best and purest. The rest is altered by a mixture of a portion of lead which it has carried up with it; and which, from its great weight and fixity, has hindered the zinc from rising so high as it would have done alone. Therefore, with this kind of impure cadmia, ductile brass cannot be made.

Almost all the zinc we have, as well as the cadmia of the furnaces, is obtained from the Ramelsberg ore, by the process described, and consequently is not the produce of a pure ore of zinc, or *lapis calaminaris*, which is never fused for that purpose. Before Mr Margraaf, although it was well known that this ore contained zinc, and that it was employed for the making of brass, a convenient process for extracting zinc from it was not known; because, when treated by fusion with fluxes, like other ores, it does not yield any zinc; which proceeds partly from the refractory quality of the earth contained in the calamine, that cannot be fused without a very violent fire; and also from the volatility and combustibility of the zinc, which for this reason cannot be collected at the bottom of a crucible, as a regulus under a scoria, like most metals.

M. Margraaf has remedied these inconveniences by distilling *lapis calaminaris*, mixed with charcoal, in a retort, to which is joined a receiver containing some water, and consequently in close vessels, where the zinc, by the help of a very strong fire indeed, is sublimed in its metallic form without burning. He also by the same method reduced into zinc the *flowers of zinc*, or *pompholix*, *cadmia of the furnaces*, *tutty*, which is also a kind of cadmia; in a word, all matters capable of producing zinc by combination with phlogiston.—But it is evident that such operations as these are rather fit to supply proofs for chemical theory, than to be put in practice for works in great. M. Margraaf has observed, that the zinc which he obtained by this process was less brittle than what is obtained from the fusion of ores; which may proceed from its greater purity, or from its better combination with phlogiston.

Zinc is obtained, not only in the method used at Goslar above-described; but is also extracted in great works, from *lapis calaminaris* and calcined blend, by a distillation similar to that by which M. Margraaf has essayed ores of zinc. The first work of that kind was erected in Sweden by Mr Von Swab, in the year 1738. The ore employed was a kind of blend; this ore, when calcined, powdered, and mixed with charcoal, was put into iron or stone retorts, and the zinc was obtained by distillation. In Bristol a work is established in which zinc is obtained by distillation *by descent*.

Fining of Silver.

After this digression which we have now made concerning the operation in the great by which zinc and cadmia are obtained, and which we could not insert elsewhere, because of the necessary relation it has with the smelting of the Rammelsberg ore, we proceed to the other operations of the same ore; that is to say, to the *finery*, by which the silver is separated from the lead, which are mixed together, forming what is called the *work*.

This operation differs from the *fining of essay*, or *in small*, principally in this circumstance, that in the latter method of fining all the litharge is absorbed into the cupel, whereas in the former method the greatest part of this litharge is withdrawn.

The fining in great of the work of Ramelsburg is performed in a furnace called a *reverberatory furnace*. This furnace is so constructed that the flame of wood burning in a cavity called the *fire-place*, is determined by a current of air (which is introduced through the ash-hole, and which goes out at an opening on one side of that part of the furnace where the work is, that is, where the lead and silver are) to circulate above, and to give the convenient degree of heat, when the fire is properly managed. In this furnace a great cupel, called a *test*, is disposed. This test is made of the ashes of beech-wood, well lixiviated in the usual manner. In some founderies different matters are added, as sand, spar, calcined gypsum, quicklime, clay. When the test is well prepared and dried, all the work is put at once upon the cold test, to the quantity of 64 quintals for one operation. Then the fire is lighted in the fire-place with faggots; but the fusion is not urged too fast, 1. That the test may have time to dry; 2. Because the work of the Ramelsberg ore is allayed by the mixture of several metallic matters, which it is proper to separate from it, otherwise they would spoil the litharge and the lead procured from it. These metallic matters are, copper, iron, zinc, and matt. As these heterogeneous substances are hard and refractory, they do not melt so soon as the work, that is, as the lead and silver; and when the work is melted, they swim upon its surface like a skin, which is to be taken off. These impurities are called the *scum*, or the *first-waste*. What remains forms a second scum, which appears when the work is at its greatest degree of heat, but before the litharge begins to form itself. It is a scoria which is to be carefully taken off. It is called the *second waste*.

When the operation is at this point, it is continued by the help of bellows, the wind of which is directed, not upon the wood or fuel, but upon the very surface of the metal, by means of iron-plates put for that purpose before the blast-hole, which are called *papillons*. This blast does not so much increase the intensity of the fire, as it facilitates the combustion of the lead, and throws the litharge that is not imbibed by the test towards a channel, called the *litharge way*, through which it flows. The litharge becomes fixed out of the furnace: the matter which is found in the middle of the largest pieces, and which amounts to about a half or a third of the whole, is friable, and falls into powder like sand. This is put into barrels containing each five quintals of it; and is called *saleable litharge*, because it is sold in that state. The other part which remains solid is called *cold litharge*, and is again melted

and

Various processes for extracting Silver.

and reduced into lead. The fusion is called *cold fusion*, and the lead obtained from it *cold lead*, which is good and saleable when the work has been well cleared from the heterogeneous matters mentioned above. The tests and cupels impregnated with litharge are added in the fusion of the ore, as we have already related.

When two thirds, or nearly that quantity, of the lead are converted into litharge, no more of it is formed. The silver then appears covered with a white skin, which the finers call *lightening*, and the metal *lightened* or *fined silver*.

The silver obtained by this process of fining is not yet altogether pure. It still contains some lead, frequently to the quantity of four drams in each marc, or eight ounces. It is delivered to the workmen, who complete its purification by the ordinary method. This last operation is the refining, and the workmen employed to do it are called *refiners*. A fining of 64 quintals of work, yields from 8 to 10 mercs of fined silver, and from 35 to 40 quintals of litharge; that is, from 12 to 18 of saleable litharge, from 22 to 23 of cold litharge, from 20 to 22 quintals of impregnated test, and from 6 to 7 quintals of lead-dross. The operation lasts from 16 to 18 hours.

§ 2. Ores containing silver may be divided into four kinds, 1. Pure, or those which are not much compounded with other metals. 2. Galenical, in which the silver is mixed with much galena, or ore of lead mineralised by sulphur. 3. Pyritous, in which the silver is mixed with the martial pyrites. 4. Cupreous; in which the silver is contained in copper ores. To extract the silver from these several kinds of ores, different operations are necessary.

Native silver is separated from its adhering earths and stones by amalgamation with mercury, in the manner directed for the separation of gold; or by fusion with lead, from which it may be afterwards separated by cupellation.

Pure ores seldom require a previous calcination; but, when bruised and cleansed from extraneous matters, may be fused directly, and incorporated with a quantity of lead; unless they contain a large proportion of sulphur and arsenic, in which case a calcination may be useful. The lead employed must be in a calcined or vitrified state, which, being mixed with the ore, and gradually reduced by the phlogiston of the charcoal added to it, may be more effectually united with the silver of the ore, than if lead itself had been added, which would too quickly precipitate to the bottom of the containing vessel or furnace. The silver is to be afterwards separated from the lead by cupellation.

Galenical ores, especially those in which pyrites is intermixed, require a calcination, which ought to be performed in an oven, or reverberatory furnace. They are then to be fused together with some inflammable matter, as charcoal, by which the lead is revived, and, together with the silver, is precipitated.

Pyritous ores must be first melted, so as to form a matt. If the sulphur is not sufficient for this kind of fusion, more sulphurated pyrites may be added. This matt contains, besides silver and sulphur, also various metals, as lead, iron, and sometimes cobalt. The matt must be exposed to repeated calcinations till the sulphur is dissipated. By these calcinations most of the iron is destroyed. The calcined matt is to be fused with litharge, and the silver incorporated with the revived lead; from which, and from the other imperfect metals with which it may be mixed, it must afterwards be separated by cupellation.

The silver contained in cupreous ores may be obtained, either, 1. By separating it from the copper itself, after this has been extracted along with the silver, in the usual manner, from the ore; or, 2. By precipitating it immediately, from the other matters of the ore.

1. It may be separated from the copper by two methods. One of these is by adding lead, and scorifying the imperfect metals. By this method much of the copper would be destroyed, and it is therefore not to be used unless the quantity of silver relatively to the copper be considerable. Another method by which silver may be separated from copper is, by eliquation; that is, by mixing the mass of copper and silver with a quantity of lead, and applying such a heat as shall be just sufficient to make the lead eliquate from the copper, together with the silver, which being more strongly disposed to unite with the lead than with the copper, is thus incorporated with the former metal, and separated from the latter.

2. Silver may also be extracted from these cupreous ores by precipitation. For this purpose, let the ore, previously bruised and cleansed, be formed into a matt, that the earthy matters may be well separated. Let the matt be then fused with a strong heat; and when the scoria has been removed, and the heat is diminished, add to it some clean galena, litharge, and granulated lead. When the fire has been raised, and the additions well incorporated with the matt, let some cast or filed iron be thrown into the liquid mass, which, being more disposed than lead is to unite with sulphur, will separate and precipitate the latter metal, and along with it the silver or gold contained in the matt. This method was introduced by Scheffer, and is practised at Adelfors in Smoland. In this work the proportion of the several materials is, four quintals of matt, two quintals of black copper containing some lead with the perfect metal, one quintal of galena, one quintal of litharge, a fifth part of a quintal of granulated lead, and an equal quantity of cast iron.

The silver in this, and in all other instances where it is united with lead, is to be afterwards separated from the lead by cupellation; which process is described at the articles Essay *of the Value of Silver*, and Refining.

Sect. V. *Smelting of Ores of Copper.*

§ 1. The smelting in great of copper ores, and even of several ores of silver and lead, excepting that of Ramelsberg, is performed in furnaces not essentially different from that already described; but in this respect only, that the scoria and metal are not drawn out of the furnace, but flow spontaneously, as soon as they are melted, into receiving basons, where the metal is freed from the scoria. These furnaces are generally called *pierced furnaces*.

Instead of a light brasque, or bed of charcoal-powder, under which the metal lies hid, the bottom of these furnaces is covered with a bason composed of heavy

heavy brafque, which is a mixture of charcoal-powder and clay. In the front of the furnace, and at the bottom of the chemife, there is a hole, called the *eye*, through which the melted matter flows, and runs along a trench or furrow, called the *trace*, into one or more receiving bafons, made of earth, fcoria, fand, &c. There the metal is feparated from the fcoria, by making it flow from thefe bafons into another lateral one. Thefe furnaces are alfo called *crooked furnaces*.

Different names are given to them according to fome difference in their conftruction. For inftance, thofe which have two eyes, and two traces, through which the melted matter flows alternately into two bafons, are called *fpectacle-furnaces*. Their greater or lefs height gives occafion alfo to the diftinction of *high furnaces*, and *middle furnaces*.

The high furnaces are of modern invention. They were firft introduced at Mansfeldt in the year 1727; and they are now ufed in almoft all countries where ores are fmelted, as in Saxony, Bohemia, Hungary, &c. Their chief advantage confifts in fimplifying and diminifhing the labour. This advantage is effected by the great height of the furnace, which allows the ore to remain there a long time before it falls down into the hotteft part of the fire and is melted. Confequently, it fuffers fucceffively different degrees of heat; and, before it is melted, it undergoes a roafting which cofts nothing: therefore the high furnaces are chiefly employed for crude fufions; and particularly for the flate-copper ore. Thefe furnaces are above 18 feet high. A too great height is attended with an inconvenience, befides the trouble of fupplying it with ore and fuel, which is, that the charcoal is moftly confumed before it gets down where the greateft heat is required, and is then rendered incapable of maintaining a fire fufficiently intenfe.

All the furnaces which we have mentioned are fupplied with large bellows, moved by the arbor of a wheel, which is turned round by a current of water.

The only kind of furnace for fmelting ores where bellows are not employed, is what is called a *reverberatory furnace*. The Germans call it a *wind-furnace*. It is alfo diftinguifhed by the name of *Englifh furnace*, becaufe the invention of it is attributed to an Englifh phyfician of the name of *Wright*, who was well verfed in chemiftry; and becaufe the ufe of it was firft introduced in England about the end of the laft century, where it is much employed, as well as in feveral other countries, as at Konigfberg, in Norway.

The length of thefe furnaces is about 18 feet, comprehending the mafonry: their breadth is 12 feet, and their height nine feet and a half. The hearth is raifed three feet above the level of the foundery: on one fide is the fire-place, under which is an afh-hole hollowed in the earth; on the other fide is a bafon made, which is kept covered with fire when there is occafion: on the anterior fide of this furnace there is a chimney, which receives the flame after it has paffed over the mineral that is laid upon the hearth. This hearth, which is in the interior part of the furnace, is made of a clay capable of fuftaining the fire. The advantage of this furnace is, that bellows are not neceffary; and confequently it may be conftructed where there is no current of water, and wherever the mine happens to be. This furnace has a hole in its front, through which the fcoria is drawn out; and a bafon, as we have faid, on one fide, made with fand, in which are oblong traces for the reception of the matt, and of the black copper, when they flow out of the furnace.

Copper is generally mineralifed, not only by fulphur and arfenic, but alfo by femimetals and pyritous matters, and is frequently mixed with other metals. As this metal has great affinity with fulphur and arfenic, it is almoft impoffible to difengage it from them entirely by roafting: hence, in the fmelting in great, nothing is obtained by the firft operation but a copper matt, which contains all the principles of the ore, excepting the earthy and ftony parts, particularly when the ore is fmelted crude and unroafted. Afterwards this matt muft be again roafted and fufed. The produce of this fecond fufion begins ftill more to refemble copper, but is not malleable. It continues mixed with almoft all the minerals, particularly with the metals. As it is frequently of a black colour, it is always called *black copper*, when it is unmalleable, whatever its colour happens really to be.

As, of all the imperfect metals, copper is moft difficultly burnt and fcorified, it is again remelted feveral times, in order to burn and fcorify the metallic fubftances mixed with it; and this is done till the copper is perfectly pure, which is then called *red* or *refined copper*, and thefe laft fufions are called the *fining* and *refining* of it: red copper contains no metals but gold and filver, if any of thefe happened to be in the ore.

In order to avoid all thefe fufions, it has been propofed to treat in the humid way certain copper ores, particularly thofe which are very pyritous. This method confifts in making blue vitriol from the ore, by roafting and lixiviating it, and in precipitating pure copper from this lixivium, which is called *cement-water*, by means of iron: but it is not much practifed, becaufe it has been obferved, that all the copper contained in the ore was not procured by this means.

As expence is not much regarded in fmall effays and experiments, thefe fufions are much abridged and facilitated by adding at firft faline and glaffy fluxes; and then by refining the black copper with lead in the cupel, as gold and filver are done. In this method of refining, it is to be moft carefully obferved, that the metal be fufed as quickly as poffible, and expofed to no more heat than is neceffary, left it be calcined.

When the black copper contains fome iron, but not a great deal, the lead prefently feparates the iron from it, and makes it rife to the furface of the copper: but if the iron be in too large a proportion, it prevents the lead from uniting with the copper. Thefe two phenomena depend on the fame caufe, which is, that lead and iron cannot unite.

Frequently copper ores contain alfo a quantity of filver fufficient to make its extraction by particular proceffes profitable. It was long before any procefs could be thought of for this purpofe which was not too expenfive and troublefome: but at length it is accomplifhed by the excellent operation called *eliquation*.

The

Smelting of Ores of Copper.

The copper from which filver has been feparated by eliquation muft be refined after this operation, as it is generally black copper from which filver is extracted: but even if it had not been black copper which was employed for this operation, it would require to be refined on account of a little lead it always retains. It is therefore carried to the refiners furnace, when this operation is performed by help of bellows, the blaft of which is thrown upon the furface of the melted metal. As in this refining of copper the precife time when it becomes pure cannot be known, becaufe fcoria is always formed on its furface, it is neceffary to ufe an effay-iron, the polifhed end of which being dipt in melted copper, fhews that this metal is pure when the copper adhering to the iron falls off as foon as it is dipt in cold water.

When this mark of the purity of the copper has been obferved, its furface ought to be well cleaned; and as foon as it begins to fix, it muft be fprinkled with a broom or befom dipped in cold water. The furface of the copper which is then fixing, being fuddenly cooled by the water, detaches itfelf from the reft of the metal, is taken hold off by tongs, and is thrown red-hot into cold water. By again fprinkling water on the mafs of copper, it is all of it reduced into plates which are called *rofettes*, and thefe plates are what is called *rofette-copper*.

§ 2. The copper of pyritous cupreous ores cannot be obtained without feveral operations, which vary according to the nature of the ores. Thefe operations are chiefly roaftings and fufions. By the firft fufion a matt is produced, which is afterwards to be roafted; and thus the fufions and roaftings are to be alternately applied, till by the laft fufion copper is obtained. Thefe methods of treating pyritous copper ores depend on the two following facts: 1. Sulphur is more difpofed to unite with iron than with copper. 2. The iron of thefe ores is deftructible by the burning fulphur during the roafting or the fufion of the ores, while the copper is not injured. This fact appears from experiments mentioned by Scheffer and by Wallerius, and from the daily practice of fmelting cupreous ores.

From thefe facts we learn, 1. That fulphur may be employed to feparate and deftroy iron mixed with copper. 2. That iron may be employed to feparate the fulphur from copper, as is fometimes done in the effay of fulphurated copper-ores. 3. That by adjufting the proportion of the iron and fulphur to each other in the fmelting of copper-ores, thefe two fubftances may be made to deftroy each other, and to procure a feparation of the copper: and this adjuftment may be effected, by adding fulphur or fulphureous pyrites to the copper-ore, when the quantity of fulphur contained in this ore relatively to the iron is too fmall; or by adding iron when the fulphur predominates; or by roafting, by which the fuperfluous fulphur may be expelled, and no more left than is fufficient for the deftruction of the iron contained in the ore. We fhall apply thefe principles to the following cafes.

1. When the quantity of fulphur and of iron in a copper-ore is fmall, and efpecially when the iron does not too much abound, a previous roafting will at once calcine the iron, and expel moft of the fulphur; fo that by one fufion the calcined iron may be fcorified, and black copper may be obtained. If the fulphur has not been fufficiently expelled, a fecond roafting and fufion are requifite; for the whole quantity of fulphur ought not to be expelled during the firft roafting: but as much ought to be left as is fufficient for the fcorification of the calcined iron; otherwife this might, during the fufion, be again revived and united with the copper.

2. If, in a copper-ore, the quantity of iron be too great, relatively to the fulphur, fome fulphurated pyrites, efpecially that kind which contains copper, ought to be added, that a matt may be obtained, and that the iron may be calcined and fcorified.

3. When the quantity of fulphur and iron is very great, that is, when the ore is very pyritous and poor, it ought to be firft formed into a matt; by which it is feparated from the adherent earths and ftones, and the bulk is diminifhed: then by repeated and alternate roaftings and fufions, the copper may be obtained.

4. When the quantity of fulphur in an ore is greater than is fufficient for the forming a matt, the fuperfluous quantity ought to be previoufly expelled by roafting.

The copper thus at firft obtained is never pure, but is generally mixed with fulphur or with iron. It is called *black copper*. This may be refined in furnaces, or on hearths.

In the former method, to the copper when melted a fmall quantity of lead is added, which unites with the fulphur, and is fcorified together with the iron, and floats upon the furface of the melted copper. This purification of copper by means of lead is fimilar to the refining of filver by cupellation; and is founded on the property of lead, by which it is more difpofed to unite with fulphur than copper is; and on a property of copper, by which it is lefs liable than any other imperfect metal to be fcorified by lead. But as copper is alfo capable of being fcorified by lead, this operation muft be no longer continued, and no more lead muft be employed, than is fufficient for the feparation of the fulphur, and for the fcorification of the iron.

The copper might alfo be purified from any remaining fulphur by adding a fufficient quantity of iron to engage the fulpur. Thus Mr Scheffer found, that by adding to fulphurated copper from $\frac{1}{20}$th to $\frac{1}{40}$th of old caft iron, he rendered the copper pure and ductile. See his Differtation on the Parting of Metals amongft the *Swedifh Memoirs* for the year 1752. In this purification, the quantity of iron added ought not to be too little, elfe all the fulphur will not be feparated; and it ought not to be too great, elfe the fuperfluous quantity will unite with and injure the purity of the copper. The fufion and fcorification, with addition of lead, feems to be the beft method for the laft purification of copper.

Sect. VI. *Smelting*, &c. *of Ores of Iron.*

Notwithstanding the great importance of this fubject, and the labours of Reaumur, Swedenborgius, and of fome other authors, we have ftill a very imperfect knowledge of the caufes of the differences of the feveral kinds of ores, of the methods of fmelting beft adapted to thefe differences, of the caufes of the good and bad qualities of different kinds of iron, and of the means of fo meliorating this metal that we may obtain tough and ductile iron from any of its ores.

Sweden-

Manufacturing of Iron.

Swedenborgius has very induſtriouſly and exactly deſcribed the different proceſſes now uſed in moſt parts of Europe for the ſmelting of ores of iron, for the forging of that metal, and for the converſion of it into ſteel: but we do not find that he or any other author have, by experiments and diſcoveries, contributed much to the illuſtration or to the improvement of this part of metallurgy, unleſs, perhaps, we except thoſe of Mr Reaumur, concerning the ſoftening of caſt iron by cementation with earthy ſubſtances.

The ores of iron are known to vary much in their appearance, in their contents, in their degrees of fuſibility, in the methods neceſſary for the extraction of their contained metal, and in the qualities of the metal when extracted.

Moſt ores require to be roaſted previouſly to their fuſion; ſome more ſlightly, and others with a more violent and longer-continued fire. Thoſe which contain much ſulphur, arſenic, or vitriolic acid, require a long-continued and repeated roaſting, that the volatile matters may be expelled. Of this kind is the black-iron ore, from which the Swediſh iron is ſaid to be obtained.

Some ores require a very ſlight roaſting only, that they may be dried and rendered friable. Such are the ores called *bog ores*, and others, which being in a calcined ſtate, and containing little ſulphureous matter, would, by a further calcination, be rendered leſs capable of being reduced to a metallic ſtate.

The roaſting of ores of iron is performed by kindling piles, conſiſting of ſtrata of fuel and of ore placed alternately upon one another, or in furnaces ſimilar to thoſe commonly employed for the calcination of limeſtone.

Some authors adviſe the addition of a calcareous earth to ſulphureous ores during the roaſting, that the ſulphur may be abſorbed by this earth when converted into quicklime. But we may obſerve, that the quicklime cannot abſorb the ſulphur or ſulphureous acid, till theſe be firſt extricated from the ore, and does therefore only prevent the diſſipation of theſe volatile matters; and, ſecondly, that the ſulphur thus united with the quicklime forms a hepar of ſulphur, which will unite with and diſſolve the ore during its fuſion, and prevent the precipitation of the metal.

The next operation is the *fuſion* or *ſmelting* of the ore. This is generally performed in furnaces or towers, from 20 to 30 feet high, in the bottom of which is a baſon for the reception of the fluid metal. When the furnace is ſufficiently heated, which muſt be done at firſt very gradually, to prevent the cracking of the walls; a quantity of the ore is to be thrown in, from time to time, at the top of the furnace, along with a certain quantity of fuel and of lime-ſtone, or whatever other flux is employed. While the fuel below is conſumed by the fire excited by the wind of the bellows, the ore, together with its proportionable quantity of fuel and of flux, ſink gradually down, till they are expoſed to the greateſt heat in the furnace. There the ore and the flux are fuſed, the metallic particles are revived by the fuel, are precipitated by means of their weight through the ſcoria formed of the lighter earthy parts of the flux and of the ore, and unite in the baſon at the bottom of the furnace, forming a maſs of fluid metal covered by a glaſſy ſcoria. When a ſufficient quantity of this fluid metal is collected, which is generally twice or thrice in 24 hours, an aperture is made, through which the metal flows into a channel or groove made in a bed of ſand; and from thence into ſmaller lateral or connected channels, or other moulds. There it is cooled, becomes ſolid, and retains the forms of the channels or moulds into which it flows. The piece of iron formed in the large channel is called a *ſow*, and thoſe formed in the ſmaller channels are called *pigs*. Sometimes the fluid iron is taken out of the furnace by means of ladles, and poured into moulds ready prepared, of ſand or of clay, and is thus formed into the various utenſils and inſtruments for which caſt iron is a proper material.

The *ſcoria* muſt be, from time to time, allowed to flow out, when a conſiderable quantity of it is formed, through an aperture made in the front of the furnace for that purpoſe. A ſufficient quantity of it muſt, however, be always left to cover the ſurface of the melted iron, elſe the ore which would fall upon it, before the ſeparation of its metallic from its unmetallic parts, would leſſen the fluidity and injure the purity of the melted metal. This ſcoria ought to have a certain degree of fluidity; for if it be too thick, the revived metallic particles will not be able to overcome its tenacity, and collect together into drops, nor be precipitated. Accordingly, a ſcoria not ſufficiently fluid, is always found to contain much metal. If the ſcoria be too thin, the metallic particles of the ore will be precipitated before they are ſufficiently metallized, and ſeparated from the earthy and unmetallic parts. A due degree of fluidity is given to the ſcoria by applying a proper heat, and by adding fluxes ſuited to the ore.

Some ores are fuſible without addition, and others cannot be ſmelted without the addition of ſubſtances capable of facilitating their fuſion.

The *fuſible ores* are thoſe which contain ſulphur, arſenic, or are mixed with ſome fuſible earth.

The *ores difficultly fuſible* are thoſe which contain no mixture of other ſubſtance. Such are moſt of the ores which contain iron in a ſtate nearly metallic. As iron itſelf, when purified from all heterogeneous matters, is ſcarcely fuſible without addition, ſo the metal contained in theſe purer kinds of ores cannot be eaſily extracted without the addition of ſome fuſible ſubſtance. 2. Thoſe which are mixed with ſome very refractory ſubſtance. Some of theſe refractory ores contain arſenic; but as this ſubſtance facilitates the fuſion of iron, we may preſume that their refractory quality depends upon a mixture of ſome unmetallic earth or other unfuſible ſubſtance. The earth which is mixed with the common calciform ores is in conſiderable quantity; and is ſometimes calcareous, ſometimes ſiliceous, and ſometimes argillaceous.

Perhaps the fuſibility of different ores depends greatly on the degree of calcination to which the metal contained in them has been reduced; ſince we have reaſon to believe, that, by a very perfect calcination, ſome metals at leaſt may be reduced to the ſtate of an earth almoſt unfuſible, and incapable of metallization; and ſince we know, that in every calcination and ſubſequent reduction of a given quantity of any imperfect

imperfect metal, a fenfible part of that quantity is always loft or deftroyed, however carefully thefe operations may have been performed. That fome of thefe ores are already too much calcined, appears from the inftance above-mentioned of the *bog ores*, which are injured by roafting; and even the great height of the common fmelting furnaces, although advantageous to many ores that require much roafting, is faid to be injurious to thofe which are already too much calcined, by expofing them to a further calcination, during their very gradual defcent, before they arrive at the hotteft part of the furnace, where they are fufed.

But as too violent calcination renders fome ores difficultly fufible, fo too flight calcination of other ores injures the purity of the metal, by leaving much of the fulphureous or other volatile matter, which ought to have been expelled.

Various *fubftances are added to affift the fufion of ores difficultly fufible*. Thefe are, 1. *Ores* of a fufible quality, or which, being mixed with others of a different quality, become fufible: accordingly, in the great works for fmelting ores of iron, two or more different kinds of ore are commonly mixed, to facilitate the fufion, and alfo to meliorate the quality of the iron. Thus an ore yielding an iron which is brittle when hot, which quality is called *red-fhort*, and another ore which produces iron brittle when cold, or *cold-fhort*, are often mixed together; not, as fometimes fuppofed, that thefe qualities are mutually deftructive of each other, but that each of them is diminifhed in the mixed mafs of iron, as much as this mafs is larger than the part of the mafs originally poffeffed of that quality. Thus, if from two fuch ores the mafs of iron obtained confifts of equal parts of cold-fhort and of red-fhort iron, it will have both thefe qualities, but will be only half as *cold-fhort* as iron obtained folely from one of the ores, and half as *red-fhort* as iron obtained only from the other ore. 2. *Earths* and *ftones* are alfo generally added to facilitate the fufion of iron ores. Thefe are fuch as are fufible, or become fufible when mixed with the ore, or with the earth adhering to it. Authors direct that, if this earth be of an argillaceous nature, limeftone or fome calcareous earth fhould be added; and that, if the adherent earth be calcareous, an argillaceous or filiceous earth fhould be added; becaufe thefe two earths, though fingly unfufible, yet, when mixed, mutually promote the fufion of each other: but as limeftone is almoft always added in the fmelting of iron ores, and as in fome of thefe, at leaft, no argillaceous earth appears to be contained, we are inclined to believe, that it generally facilitates the fufion, not merely by uniting with thofe earths, but by uniting with that part of the ore which is moft perfectly calcined, and leaft difpofed to metallization; fince we know, that by mixing a calciform or roafted ore of iron with calcareous earth, without any inflammable matter, thefe two fubftances may be totally vitrified. See *Experiments made upon quicklime and upon iron, by Mr Brandt, in the Swedifh Memoirs for the years* 1749 *and* 1751. Calcareous earth does indeed fo powerfully facilitate the fufion of iron ores, that it deferves to be confidered whether workmen do not generally ufe too great a quantity of it, in order to haften the operation. For when the fcoria is rendered too thin, much earthy or unmetallized matter is precipitated, and the caft iron produced is of too vitreous a quality, and not fufficiently approximated to its true metallic ftate.

Some authors pretend, that a principal ufe of the addition of limeftone in the fmelting of iron ores is to abforb the fulphur, or vitriolic acid, of thefe ores: but, as we have already obferved, a hepar of fulphur is formed by that mixture of calcareous earth and fulphur, which is capable of diffolving iron in a metallic ftate; and thus the quantity of metal obtained from an ore not fufficiently divefted of its fulphur, or vitriolic acid, (which, by uniting with the fuel, is formed into a fulphur during the fmelting,) muft be confiderably diminifhed, though rendered purer, by addition of calcareous earth: hence the utility appears of previoufly expelling the fulphur and vitriolic acid from the ore by a fufficient roafting. 3. The *fcoria* of former fmeltings is frequently added to affift the fufion of the ore; and, when the fcoria contains much iron, as fometimes happens in ill-conducted operations, it alfo increafes the quantity of metal obtained.

The quantity of thefe fufible matters to be added varies according to the nature of the ore; but ought in general to be fuch, that the fcoria fhall have its requifite degree of thinnefs, as is mentioned above.

The *fuel* ufed in moft parts of Europe for the fmelting of ores of iron is charcoal. Lately, in feveral works in England and Scotland, iron ore has been fmelted by means of pit-coal, previoufly reduced to cinders or *coaks*, by a kind of calcination fimilar to the operation for converting wood into charcoal, by which the aqueous and fulphureous parts of the coal are expelled, while only the more fixed bituminous parts are left behind. In France, pit-coal not calcined has been tried for this purpofe, but unfuccefsfully. The ufe of *peat* has alfo been introduced in fome parts of England.

The quality of the iron depends confiderably upon the quality and alfo upon the quantity of the fuel employed. Charcoal is fitter than coaks for producing an iron capable of being rendered malleable by forging.

The quantity of fuel, or the intenfity of the heat, muft be fuited to the greater or lefs fufibility of the ore. Sulphureous, and other ores eafily fufible, require lefs fuel than ores difficultly fufible. In general, if the *quantity of fuel be too fmall*, and the heat not fufficiently intenfe, all the iron will not be reduced, and much of it will remain in the fcoria, which will not be fufficiently thin. This defect of fuel may be known by the blacknefs and compactnefs of the fcoria; by the qualities of the iron obtained, which in this cafe is hard, white, light, intermixed with fcoria, fmooth in its texture, without fcales or grains, rough and convex in its furface, and liable to great lofs of weight by being forged; and, laftly, it may be known by obferving the colour and appearance of the drops of metal falling down from the fmelted ore, and of the fcoria upon the furface of the fluid metal, both which are darker-coloured than when more fuel is ufed. When the *quantity of fuel is fufficiently large*, and the heat is intenfe enough, the iron is darker-coloured,

Manufacturing of Iron.

coloured, denser, more tenacious, contains less scoria, and is therefore less fusible, and loses less of its weight by being forged. Its surface is also smoother and somewhat concave; and its texture is generally granulated. The scoria, in this case, is of a lighter colour, and less dense. The drops falling down from the smelted ore and the liquid scoria in the furnace appear hotter and of a brighter colour. When the quantity of fuel is too great, and the heat too intense, the iron will appear to have a still darker colour, and more conspicuous grains or plates, and the scoria will be lighter, whiter, and more spungy. The drops falling from the smelted ore, and the fluid scoria, will appear to a person looking into the furnace through the blast-hole to be very white and shining hot. The quantity of charcoal necessary to produce five hundred weight of iron, when the ore is rich, the furnace well contrived, and the operation skilfully conducted, is computed to be about 40 cubic feet; but is much more in contrary circumstances.

The *time, during which the fluid metal ought to be kept in fusion* before it is allowed to flow out of the furnace, must be also attended to. How long that time is, and whether it ought not to vary according to the qualities of ores and other circumstances, we cannot determine. In some works the metal is allowed to flow out of the furnace every six or eight, and in others only every 10 or 12, hours. Some workmen imagine, that a considerable time is necessary for the concoction of the metal. This is certain, that the iron undergoes some change by being kept in a fluid state; and that if its fusion be prolonged much beyond the usual time, it is rendered less fluid, and also its cohesion, when it becomes cold, is thereby greatly diminished. The marquis de Courtivron says, that the cohesion may be restored to iron in this state, by adding to it some vitrescible earth, which he considers as one of the constituent parts of iron, and which he thinks is destroyed by the fusion too long continued. That the fusibility of cast iron does depend on an admixture of some vitrescible earth, appears probable from the great quantity of scoria forced out of iron during its conversion into malleable or forged iron, and from the loss of fusibility which it suffers nearly in proportion to its loss of scoria. The quantity of iron daily obtained from such a furnace as is above described, is from two to five tons in 24 hours, according to the richness and fusibility of the ore, to the construction of the furnace, to the adjustment of the due quantity of flux and of fuel, and to the skill employed in conducting the operation.

The *quality of the iron* is judged by observing the appearances during its flowing from the furnace, and when it is fixed and cold. If the fluid iron, while it flows, emits many and large sparkles; if many brown spots appear on it while it is yet red-hot; if, when it is fixed and cold, its corners and edges are thick and rough, and its surface is spotted; it is known to have a red-short quality. If, in flowing, the iron seems covered with a thin glassy crust, and if, when cold, its texture be whitish, it is believed to be cold-short. Mr Reaumur says, that dark-coloured cast iron is more impure than that which is white. The marquis de Courtivron is of a contrary opinion. But no certain rules for judging of the quality of iron before it be forged can be given. From brittle cast iron, sometimes ductile forged iron is produced. Cast iron with brilliant plates and points, when forged, becomes sometimes red-short and sometimes cold-short. Large shining plates, large cavities called *eyes*, want of sufficient density, are almost certain marks of bad iron; but whether it will be cold or red-short cannot be affirmed till it be forged. Whiteness of colour, brittleness, closeness of texture, and hardness, are given to almost any cast iron by sudden cooling; and we may observe, that in general the whither the metal is, the harder it is also, whether these properties proceed from the quality of the iron, or from sudden cooling; and that, therefore, the darker-coloured iron is fitter for being cast into moulds, because it is capable in some measure of being filed and polished, especially after it has been exposed during several hours to a red-heat in a reverberatory furnace, and very gradually cooled. This operation, called by workmen *annealing*, changes the texture of the metal, renders it softer, and more capable of being filed than before, and also considerably less brittle.

Mr Reaumur found, that by cementing cast iron with absorbent earths in a red-heat, the metal may be rendered softer, tougher, and consequently a fit material for many utensils formerly made of forged iron. Whether cementation with absorbent earths gives to cast iron a greater degree of these properties than the annealing commonly practised, has not been yet determined.

In Navarre, and in some of the southern parts of France, iron-ore is smelted in furnaces much smaller, and of a very different construction form those above described. A furnace of this kind consists of a wide-mouthed copper-caldron, the inner surface of which is lined with masonry a foot thick. The mouth of the caldron is nearly of an oval or elliptic form. The space or cavity contained by the masonry is the furnace in which the ore is smelted. The depth of this cavity is equal to two feet and a half: the larger diameter of the oval mouth of the cavity is about eight feet, and its smaller diameter is about six feet: the space of the furnace is gradually contracted towards the bottom, the greatest diameter of which does not exceed six feet: eighteen inches above the bottom is a cylindrical channel in one of the longer sides of the caldron and masonry, through which the nozzle of the bellows passes. This channel, and also the bellows-pipe, are so inclined, that the wind is directed towards the lowest point of the opposite side of the furnace. Another cylindrical channel is in one of the shorter sides of the furnace, at the height of a few inches from the bottom, which is generally kept closed, and is opened occasionally to give passage to the scoria; and above this is a third channel in the same side of the furnace, through which an iron instrument is occasionally introduced to stir the fluid metal, and to assist, as is said, the separation of the scoria from it. The greatest height of this channel is at its external aperture on the outside of the furnace, and its smaller height is at its internal aperture; so that the instrument may be directed towards the bottom of the furnace; but the second channel below it has a contrary inclination, that, when an opening is made, the scoria may flow out of the furnace into a bason

Manufacturing of Iron.

bason placed for its reception. When the furnace is heated sufficiently, the workmen begin to throw into it alternate changes of charcoal, and of ore previously roasted. They take care to throw the charcoal chiefly on that side at which the wind enters, and the ore at the opposite side. At the end of about four hours a mass of iron is collected at the bottom of the furnace, which is generally about 600 weight; the bellows are then stopt: and when the mass of iron is become solid, the workmen raise it from the bottom of the furnace, and place it, while yet soft, under a large hammer, where it is forged. The iron produced in these furnaces is of the best quality; the quantity is also very considerable, in proportion to the quantity of ore, and to the quantity of fuel employed. In these furnaces no limestone or other substance is used to facilitate the fusion of the ore. We should receive much instruction concerning the smelting of iron-ore, if we knew upon what part of the process, or circumstance, the excellence of the iron obtained in these furnaces depends; whether on the quality of the ore; on the disuse of any kind of flux, by which the proportion of vitreous or earthy matter, intermixed with the metallic particles, is diminished; on the forging while the iron is yet soft and hot, as the Marquis de Courtivron thinks; or on some other cause, not observed.

The iron thus produced by smelting ores is very far from being a pure metal; and though its fusibility renders it very useful for the formation of cannon, pots, and a great variety of utensils, yet it wants the strength, toughness, and malleability, which it is capable of receiving by further operations.

Cast-iron seems to contain a large quantity of vitreous or earthy matter mixed with the pure iron; which matter is probably the chief cause of its fusibility, brittleness, hardness, and other properties by which it differs from forged iron. The sulphur, arsenic, and other impurities of the ore, which are sometimes contained in cast-iron, are probably only accidental, and may be the causes of the red-short quality, and of other properties of certain kinds of iron: but the earthy matter above-mentioned seems principally to distinguish cast-iron from forged or malleable iron; for, first, by depriving the former of this earthy matter, it is rendered malleable, as in the common process hereafter to be discribed; and, secondly, by fusing malleable iron with earthy and vitrescible matters, it loses its malleability, and is restored to the state and properties of cast-iron.

The earthy vitreous matter contained in cast-iron consists probably of some of the ferruginous earth or calx of the ore not sufficiently metallised, and also of some unmetallic earth. Perhaps it is only a part of the scoria which adheres to, and is precipitated with, the metallic particles, from which it is more and more separated, as the heat applied is more intense, and as the fusion is longer continued.

To separate these impurities from cast-iron, and to unite the metallic parts more closely and compactly, and thus to give it the ductility and tenacity which render this metal more useful than any other, are the effects produced by the following operations.

The first of these operations is a fusion of the iron, by which much of its impurities is separated in form of scoria; and by the second operation, a further and more complete separation of these impurities, and also a closer compaction of the metallic particles, are effected by the application of mechanical force or pressure, by means of large hammers.

Some differences in the construction of the forge or furnace, in which the *fusion* or *refining of cast-iron* is performed, in the method of conducting the operation, and in other circumstances, are observed to occur in different places. We shall describe from Swedenborgius the *German method*.

The fusion of the cast-iron, which is to be rendered malleable, is performed upon the hearth of a forge similar to that used by blacksmiths: at one side of this hearth is formed a cavity or fire-place, which is intended to contain the fuel and the iron to be melted: this fire-place is 20 inches long, 18 inches broad, and 12 or 14 inches deep: it is bounded on three sides by three plates of cast-iron placed upright; and on the fourth side, which is the front, or that part nearest to which the workmen stand, by a large forge-hammer, through the eye of which the scoria is at certain times allowed to flow. The floor also of the fire-place is another cast-iron plate. The thickness of these plates is from two to four inches. One of the upright side-plates rests against a wall, in an aperture through which a copper tube, called the *tuyere*, is luted with clay. This tube is a kind of case or covering for the pipe of a pair of bellows placed behind the wall, and its direction is therefore parallel to that of the bellows-pipe; but it advances about half a foot further than this pipe into the fire-place; and thus gives greater force to the air, which it keeps concentrated, or prevents the divergency of the air, till it is required to act. The tube rests upon the edge of the side-plate which leans against the wall, nearer to the back-part than to the front of the fire-place, and in such an oblique direction, that the wind shall be impelled towards the furthest part of the floor of the fire-place, or where this floor is intersected by the opposite side-plate. The obliquity of the tuyere ought to vary according to the quality of the iron: and therefore, in every operation, it may be shifted till its proper position is found. The more nearly its direction approaches to a horizontal plane, the more intense is the heat; but a larger quantity of fuel is consumed than is even proportional to the increase of heat, because the flame is not then so well confined. When the iron is easily fusible, great heat is not required: the tuyere may then decline considerably from the horizontal plane, and thus fuel may be saved. This tuyere, tho' made of copper, a metal more easily fusible than iron, is preserved from fusion by the constant passage of cold air through it. It must be carefully kept open, and cleansed from the scoria, which would be apt to block up its cavity, by which not only the heat would be too much diminished for the success of the operation, but the tube itself would be melted.

To prepare for the fusion, a quantity of scoria of a former operation is thrown into the fire-place, till one-third part of this be full; and the remaining two-thirds of the fire-place are to be filled with smaller scoria, coal-dust, and sparks ejected from hot iron. These matters, being fusible, form a bath for the reception of the iron when melted. Upon this bed of scoria, the mass of cast-iron to be melted is placed; so-

fo that one end of it fhall be within the fire-place, oppofite to the tuyere, and at the diftance of about four or five inches from its aperture; and the other end fhall ftand without the fire-place, to be pufhed in, as the former is melted. The upper fide of the mafs of iron ought to be in the fame horizontal plane as the upper part of the orifice of the tuyere, that the wind may, by means of the obliquity of its courfe, ftrike upon and pafs along the under-fide of the mafs: but if the iron be difficultly fufible, the tuyere is to be difpofed more horizontally, fo that the wind fhall ftrike directly upon the mafs of iron; and that one part of the blaft fhall graze along the upper furface, and the other part along the under furface of the iron. The mafs of iron weighs generally from 200 to 400 pounds. Sometimes two or three fmaller maffes are put one above another, fo as not to touch. When thefe are of different qualities, the cold-fhort piece is placed undermoft, that being more unfufible than the red-fhort. The iron being placed, charcoal-powder is thrown on both fides, and coals are accumulated above, fo as to cover entirely the iron.

The coals are then to be kindled, and the bellows are made to blow, at firft flowly, and afterwards with more and more force. The iron is gradually liquefied, and flows down in drops through the melted fcoria to the bottom of the fire-place; during which the workmen frequently turn the iron, fo that the end oppofed to the blaft of wind may be equally expofed to heat, and uniformly fufed. While the coals are confumed, more are thrown on, fo that the whole may be kept quite covered. During the operation, a workman frequently founds the bottom and corners of the fire-place by means of a bar or poker, raifes up any mafs of metal which he finds adhering to thefe, and expofes them to the greateft heat, that they may be more perfectly fufed.

When all the iron is fufed, no more coals are to be added; but the melted mafs is to remain half uncovered for fome time; during which the iron boils and bubbles, and its furface fwells and rifes higher and higher. When the iron has rifen as high as the upper edge of the fire-place, the coals upon its furface muft be removed; and by thus expofing it to cold air, its ebullition and fwelling fubfide. In this ftate, or coction, the iron is kept during half an hour or more, by adding occafionally pieces of good coal, which maintain a fufficient heat, without covering entirely the furface of the mafs. During this coction, the workmen allow the orifice of the tuyere to be half ftopped up by the fcoria, that the air may not blow upon the iron with all its force, by which it would be too much cooled. Accordingly, when they think that the coction has continued fufficiently long, they clear the paffage of the tuyere, and the mafs is foon cooled by the cold air. At the fame time alfo, they open a paffage in the eye of the hammer placed in the front of the fire-place, through which fome of the fcoria is allowed to flow out. When the iron has become folid, the bellows are ftopt, the coals are removed, and the mafs is left during an hour; and then the workmen raife it from the fire-place, turn it upfide down, and proceed to the fecond coction or fufion of the iron.

From this fecond operation, the mafs is to be fo placed, that one part of it fhall reft upon the tuyere, and the other upon the fcoria remaining in the fire-place. This fcoria is to be difpofed in an oblique direction parallel to the tuyere, by which means the wind of the bellows is obliged to pafs along the under fide of the mafs of iron. About the fides of the mafs, charcoal-powder and burnt afhes are thrown; but towards the tuyere, dry and entire pieces of coals are placed, to maintain the fire. When thefe are kindled, more coals are added, and the fire is gradually excited. The workman attends to the direction of the flame, that it pafs equally along the under furface of the iron, quite to the further extremity, and that it do not efcape at the fides, nor be reverberated back towards the tuyere, by which this copper tube might be melted. During this fufion, pieces of iron are apt to be feparated from the mafs, and to fall down unfufed to the bottom and corners of the fire-place. Thefe are carefully to be fearched for, and expofed to the greateft heat till they are melted. When the whofe mafs is thus brought into perfect fufion, the coals are removed; and the wind blowing on its furface, whirls and diffipates the fmall remaining pieces of fcoria, and fparks thrown out from the fluid iron. This jet of fire continues about feven or eight minutes, and the whole operation about two hours. In this fecond fufion the fcoria is to be thrice removed, by opening a paffage through the eye of the hammer. The firft time of removing the fcoria is about 20 minutes from the kindling of the fire, the fecond time is about 40 minutes after the firft, and the third time is near the end of the operation.

The mafs is then removed from the hearth, and put upon the ground of the forge, where it is cleanfed from fcoria, and beat into a more uniform fhape. It is then placed on an anvil, where, by being forged, it receives a form nearly cubical. This mafs is to be divided into five, fix, or more pieces, by means of a wedge; and thefe are to be heated and forged till they are reduced to the form of the bars commonly fold.

In fome forges, the iron is fufed only once, and in others it fuffers three fufions, by which it is faid to be rendered very pure. Where only one fufion is practifed, it is called the *French method*. In this, no greater quantity of iron is fufed at once than is fufficient to make one bar. The fire-place is of confiderable lefs dimenfions, and efpecially is lefs deep, than in the German method above defcribed. The fire is alfo more intenfe, and the proportion of fuel confumed to the iron is greater. The iron, when melted, is not kept in a ftate of ebullition as is above defcribed; but this ebullition is prevented by ftirring the fluid mafs with an iron bar, till it is coagulated, and becomes folid.

By thefe operations, fufion and forging, the iron lofes about $\frac{3}{13}$ parts of its former weight, fometimes more and fometimes lefs, according to the quality of the caft-iron employed; it is purified from the vitreous and earthy parts which were intermixed with it, its metallic particles are more clofely compacted, its texture is changed, and it is rendered more denfe, foft, and malleable, tough, and difficultly fufible.

The degrees, however, of thefe qualities vary much in different kinds of iron. Thus fome iron is tough and malleable, both when it is hot and when it is cold. This

This is the beſt and moſt uſeful iron. It may be known generally by the equable ſurface of the forged bar, which is free from tranſverſe fiſſures or cracks in the edges, and by a clear, white, ſmall-grained, or rather fibrous texture. Another kind is tough when it is heated, but brittle when it is cold. This is called *cold ſhort* iron; and is generally known by a texture conſiſting of large, ſhining plates, without any fibres. It is leſs liable to ruſt than other iron. A third kind of iron, called *red-ſhort*, is brittle when hot, and malleable when cold. On the ſurface and edges of the bars of this kind of iron, tranſverſe cracks or fiſſures may be ſeen; and its internal colour is dull and dark. It is very liable to ruſt. Laſtly, ſome iron is brittle both when hot and when cold.

Moſt authors agree, that the red-ſhort quality of iron proceeds from ſome ſulphur or vitriolic acid being contained in it, becauſe ſulphur is known to produce this effect when added to iron, and becauſe the iron obtained from pyritous and other ſulphurated ores has generally this quality.

The cauſe of the cold-ſhort quality of iron is not ſo well aſcertained. Some imagine, that it proceeds from a mixture of arſenic or of antimony. But this opinion ſeems to be improbable, when we conſider that theſe metallic ſubſtances may in a great meaſure be diſſipated by roaſting, whereas the ores which yield a cold-ſhort iron are injured by much roaſting; that no arſenic or antimony are obſervable in moſt, if in any, of theſe ores; and laſtly, that theſe ſemi-metals would render the iron brittle both when hot and when cold. Cramer and other authors impute this vicious quality to a mixture of an unmetallic earth or vitreous matter; and affirm, that it may be deſtroyed by cementation with phlogiſton, and by forging. And laſtly, others aſcribe the cold-ſhort quality of iron to a defect of phlogiſton, or, as Swedenborgius ſays, of ſulphur. To aſcertain the cauſes of the bad qualities of iron, and to diſcover practical remedies, are ſtill deſiderata in metallurgy.

In one bar frequently two or more different kinds of iron may be obſerved, which run all along its whole length; and ſcarcely a bar is ever found of entirely pure and homogeneous iron. This difference probably proceeds from the practice we have mentioned of mixing different kinds of ores together, in the ſmelting; and alſo from the practice of mixing two or more pigs of caſt iron of different qualities in the finery of theſe; by which means, the red-ſhort and cold-ſhort qualities of the different kinds are not, as we have already remarked, mutually counteracted or deſtroyed by each other, but each of theſe qualities is diminiſhed in the mixed maſs of iron, as much as this maſs is larger than the part of the maſs originally poſſeſſed of that quality: that is, if equal parts of red-ſhort and of cold-ſhort iron be mixed together, the mixed maſs will be only half as red-ſhort as the former part, and half as cold-ſhort as the latter. For theſe different kinds of iron ſeem as if they were only capable of being interwoven and diffuſed thro' each other, but not of being intimately united or combined.

The quality of forged iron may be known by the texture which appears on breaking a bar. The beſt and tougheſt iron is that which has the moſt fibrous texture, and is of a clear greyiſh colour. This fibrous appearance is given by the reſiſtance which the particles of the iron make to their rupture. The next beſt iron is that whoſe texture conſiſts of clear, whitiſh, ſmall grains, intermixed with fibres. Theſe two kinds are malleable, both when hot and when cold, and have great tenacity. *Cold-ſhort iron* is known by a texture conſiſting of large, ſhining plates, without fibres: and *red-ſhort iron* is diſtinguiſhed by its dark dull colour, and by the tranſverſe cracks and fiſſures on the ſurface and edges of the bars. The quality of iron may be much improved by violent compreſſion, as by forging and rolling; eſpecially when it is not long expoſed to too violent heat, which is known to injure, and at length to deſtroy its metallic properties.

For the converſion of iron into *ſteel*, ſee the article Steel.

Sect. VII. *Of the Smelting of Tin Ores.*

The tin-ores commonly ſmelted are thoſe which conſiſt of calx of tin combined with calx of arſenic and ſometimes with calx of iron. Theſe are either pure, as the tin-grains, or intermixed with ſpars, ſtones, pyrites, ores of copper, iron, or of other metals.

The impure ores muſt be cleanſed as much as is poſſible from all heterogeneous matters. This cleanſing is more neceſſary in ores of tin than of any other metal; becauſe in the ſmelting of tin-ores a leſs intenſe heat muſt be given than is ſufficient for the ſcorification of earthy matters, leſt the tin be calcined. Tin-ores previouſly bruiſed may be cleanſed by waſhing, for which operation their great weight and hardneſs render them well adapted. If they be intermixed with very hard ſtones or ferruginous ores, a ſlight roaſting will render theſe impure matters more friable, and conſequently fitter to be ſeparated from the tin-ores. Sometimes theſe operations, the roaſting, contuſion, and lotion, muſt be repeated. By roaſting, the ferruginous particles are ſo far revived, that they may be ſeparated by magnets.

The ore, thus cleanſed from adhering heterogeneous matters, is to be roaſted in an oven or reverberatory furnace with a fire rather intenſe than long continued, during which it muſt be frequently ſtirred to prevent its fuſion. By this operation, the arſenic is expelled, and in ſome works is collected in chambers built purpoſely above the calcining furnace.

Laſtly, the ore cleanſed and roaſted is to be fuſed, and reduced to a metallic ſtate. In this fuſion, attention muſt be given to the following particulars. 1. No more heat is to be applied than is ſufficient for the reduction of the ore; becauſe this metal is fuſible with very little heat, and is very eaſily calcinable. 2. To prevent this calcination of the reduced metal, a larger quantity of charcoal is uſed in this than in moſt other fuſions. 3. The ſcoria muſt be frequently removed, leſt ſome of the tin ſhould be involved in it, and the melted metal muſt be covered with charcoal powder to prevent the calcination of its ſurface. 4. No flux or other ſubſtance, excepting the ſcoria of former ſmeltings which contains ſome tin, are to be added, to facilitate the fuſion.

Sect. VIII. *Smelting of Ores of Lead.*

Ores of lead are either pure, that is, containing no

Smelting of Tin ores.

no mixture of other metal; or they are mixed with silver, copper, or pyrites. The methods of treating ores of lead containing silver and copper, are described in the sections of *Smelting of Ores of Silver* and *of Copper;* and in the former of these an instance is given of the method of smelting the ore of Rammelsberg, which contains all these three metals.

Pure ores of lead, and those which contain so small a quantity only of silver as not to compensate for the expence of extracting the nobler metal, may be smelted in furnaces, and by operations similar to those used at Rammelsberg, or in the following methods. 1. From the lead-ore of Willach in Carinthia, a great part of the lead is obtained by a kind of eliquation, during the roasting of the ore. For this purpose, the ore is thrown upon several strata or layers of wood, placed in a calcining or reverberatory furnace. By kindling this wood, a great part of the lead flows out of the ore, through the layers of fuel, into a bason placed for its reception. The ore which is thus roasted is beat into smaller pieces, and exposed to a second operation similar to the former, by which more metal is eliquated; and the remaining ore is afterwards ground, washed, and smelted, in the ordinary method.

The lead of Willach is the purest of any known. Schlutter ascribes its great purity to the method used in extracting it, by which the most fusible, and consequently the purest part of the contained lead is separated from any less fusible metal which happens to be mixed with it, and which remains in the roasted ore. This method requires a very large quantity of wood.

2. In England, lead ores are smelted either upon a hearth, or in a reverberatory furnace called *a cupel.*

In the first of these methods, charcoal is employed as fuel, and the fire is excited by bellows. Small quantities of fuel and of ore are thrown alternately and frequently upon the hearth. The fusion is very quickly effected; and the lead flows from the hearth as fast as it is separated from the ore.

3. In the second method practised in England, pitcoal is used as fuel. The ore is melted by means of the flame passing over its surface; its sulphur is burnt and dissipated, while the metal is separated from the scoria, and collected at the bottom of the furnace. When the ore is well cleansed and pure, no addition is requisite; but when it is mixed with calcareous or earthy matrix, a kind of fluor or fusible spar found in the mines is generally added to render the scoria more fluid, and thereby to assist the precipitation of the metal. When the fusion has been continued about eight hours, a passage in the side of the furnace is opened, through which the liquid lead flows into an iron cistern. But immediately before the lead is allowed to flow out of the furnace, the workmen throw upon the liquid mass a quantity of slacked quicklime, which renders the scoria so thick and tenacious, that it may be drawn out of the furnace by rakes. Schlutter mentions this addition of quicklime in the smelting of lead ores in England, but thinks that it is intended to facilitate the fusion of the ores; whereas it really has a contrary effect, and is never added till near the end of the operation, when the scoria is to be raked from the surface of the metal.

Smelting of ores of Semimetals.

Sect. IX. *Of the Smelting of Ores of Semimetals.*

Antimony is obtained by a kind of eliquation from the minerals containing it, as is described in the article Antimony; and the regulus of antimony is procured from antimony, by the processes described in the same article, and in the article Regulus *of* Antimony.

Arsenic, saffre, and *bismuth,* are obtained generally from one ore, namely, that called *cobalt.* The arsenic of the ore is separated by roasting, and adheres to the internal surface of a chimney, which is extended horizontally about 200 or 300 feet in length, and in the sides of which are several doors, by means of which the arsenic, when the operation is finished, may be swept out and collected. These chimneys are generally bent in a zig-zag direction, that they may better retard and stop the arsenical flowers. These flowers are of various colours, white, grey, red, yellow, according to the quantity of sulphur or other impurity, with which they happen to be mixed. They are afterwards purified by repeated sublimations; while some alkaline or other substances are added to detain the sulphur, and to assist the purification.

In the same roasting of the ore by which the arsenic is expelled, the bismuth, or at least the greatest part of this semi-metal which is contained in the ore, being very fusible, and having no disposition to unite with the regulus of cobalt, which remains in the ore, is separated by eliquation.

The remaining part of the roasted ore consists chiefly of calx of regulus of cobalt, which not being volatile, as the arsenic is, nor so easily fusible as bismuth is, has been neither volatilized nor melted. It contains also some bismuth, and a small quantity of arsenic, together with any silver or other fixed metal which happened to be contained in the ore. This roasted ore being reduced to a fine powder, and mixed with three or four times its weight of fine sand, is the powder called *saffre* or *zaffre.* Or the roasted ore is sometimes fused See *Zaffre*.
with about thrice its quantity of pure sand and as much pure pot-ash, by which a blue glass, called *smalt,* See *Smalt*.
is produced; and a metallic mass, called *speiss,* is collected at the bottom of the vessel in which the matters are fused. The metallic mass or speiss is composed of very different substances, according to the contents of the ore and the methods of treating it. The matters which it contains at different times are, nickel, regulus of cobalt, bismuth, arsenic, sulphur, copper, and silver.

Bismuth is seldom procured from any other ores but that of cobalt. It might, however, be extracted from its proper ores, if a sufficient quantity of these were found, by the same method by which it is obtained from cobalt, namely, by eliquation.

Mercury, when native, and inveloped in much earthy or other matter, from which it cannot be separated merely by washing, is distilled either by ascent or by descent. When it is mineralised by sulphur, that is, when it is contained in cinnabar, some intermediate substance, as quicklime, or iron, must be added in the distillation, to disengage it from the sulphur.

The rich ore of Almaden in Spain is a cinnabar, with which a calcareous stone happens to be so blend-

Smelting of ores of Semimetals.

ed, that no addition is required to disengage the mercury from the sulphur. The distillation is there performed in a furnace consisting of two cavities, one of which is placed above another. The lower cavity is the fire-place, and contains the fuel, resting upon a grate, through the bars of which the air enters, maintains the fire, and passes into a chimney, placed at one side of the fire-place immediately above the door thro' which fuel is to be introduced. The roof of this fire-place, which is vaulted and pierced with several holes, is also the floor of the upper cavity. Into this upper cavity, the mineral from which mercury is to be distilled is introduced, through a door in one of the sides of the furnace. In the opposite wall of this cavity are eight openings, all at the same height. To each of these openings is adapted a file of aludels connected and luted together, extending 60 feet in length. These aludels, which are earthen vessels open at each end, and wider in the middle than at either extremity, are supported upon an inclined terras; and the aludel of each file, that is most distant from the furnace, terminates in a chamber built of bricks, which has two doors, and two chimneys.

When the upper cavity is filled sufficiently with the mineral, a fire is made below, which is continued during 12 or 14 hours. The heat is communicated thro' the holes of the vaulted roof of the fire-place to the mineral in the upper cavity, by which means the mercury is volatilised, and its vapour passes into the aludels, where much of it is condensed, and the rest is discharged into the brick-chamber, in which it circulates till it also is condensed. If any air or smoke passes through the aludels along with the vapour of the mercury, they escape thro' the two chimneys of the chamber. Three days after the operation, when the apparatus is sufficiently cooled, the aludels are unluted, the doors of the chamber are opened, and the mercury is collected.

Metamorphosis, Metaphor.

METAMORPHOSIS, in general, denotes the changing of something into a different form; in which sense it includes the transformation of insects, as well as the mythological changes related by the ancient poets.

Mythological metamorphoses were held to be of two kinds, apparent and real: thus, that of Jupiter into a bull, was only apparent; whereas that of Lycaon into a wolf, was supposed to be real.

Most of the ancient metamorphoses include some allegorical meaning, relating either to physics or morality: some authors are even of opinion that a great part of the ancient philosophy is couched under them; and Lord Bacon and Dr Hook have attempted to unriddle several of them.

METAPHOR, in rhetoric. See ORATORY, n° 50.

METAPHOR *and Allegory*, in poetry.—A metaphor differs from a simile, in form only, not in substance: in a simile the two subjects are kept distinct in the expression, as well as in the thought; in a metaphor, the two subjects are kept distinct in the thought only, not in the expression. A hero resembles a lion, and upon that resemblance many similies have been raised by Homer and other poets. But instead of resembling a lion, let us take the aid of the imagination, and feign or figure the hero to be a lion: by that variation the simile is converted into a metaphor; which is carried on by describing all the qualities of a lion that resemble those of the hero. The fundamental pleasure here, that of resemblance, belongs to the thought. An additional pleasure arises from the expression: the poet, by figuring his hero to be a lion, goes on to describe the lion in appearance, but in reality the hero; and his description is peculiarly beautiful, by expressing the virtues and qualities of the hero in new terms, which, properly speaking, belong not to him, but to the lion. This will better be understood by examples. A family connected with a common parent, resembles a tree, the trunk and branches of which are connected with a common root: but let us suppose, that a family is figured, not barely to be like a tree, but to be a tree; and then the simile will be converted into a metaphor, in the following manner.

Metaphor.

Edward's sev'n sons, whereof thyself art one,
Were sev'n fair branches, springing from one root;
Some of these branches by the dest'nies cut:
But Thomas, my dear lord, my life, my Glo'ster,
One flourishing branch of his most royal root,
Is hack'd down, and his summer-leaves all faded,
By Envy's hand and Murder's bloody axe.
Richard II. *act* i. *sc.* 3.

Figuring human life to be a voyage at sea:

There is a tide in the affairs of men,
Which, taken at the flood, leads one to Fortune:
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures. *Julius Cæsar, act* iv. *sc.* 5.

Figuring glory and honour to be a garland of flowers:

* *Hotspur.* ——————Wou'd to heav'n,
Thy name in arms were now as great as mine!
Pr. Henry. I'll make it greater, ere I part from thee;
And all the budding honours on thy crest
I'll crop, to make a garland for my head.
First part of Henry IV. *act* v. *sc.* 9.

Figuring a man who hath acquired great reputation and honour to be a tree full of fruit:

——————Oh, boys, this story
The world may read in me: my body's mark'd
With Roman swords; and my report was once
First with the best of note. Cymbeline lov'd me;
And when a soldier was the theme, my name
Was not far off: then was I as a tree,
Whose boughs did bend with fruit. But in one night,
A storm or robbery, call it what you will,
Shook down my mellow hangings, nay my leaves;
And left me bare to weather.
Cymbeline, act iii. *sc.* 3.

"Blest be thy soul, thou king of shells, said Swaran of the dark-brown shield. In peace, thou art the gale of spring; in war, the mountain-storm. Take now my hand in friendship, thou noble king of Morven."
Fingal.

"Thou

Metaphor.

"Thou dwelleft in the foul of Malvina, fon of mighty Offian. My fighs arife with the beam of the eaft: my tears defcend with the drops of night. I was a lovely tree in thy prefence, Ofcar, with all my branches round me: but thy death came like a blaft from the defart, and laid my green head low; the fpring returned with its fhowers, but no leaf of mine arofe."

Fingal.

An *allegory* differs from a metaphor; and what lord Kaim's calls a *figure of fpeech* differs from both. A metaphor is defined above to be an act of the imagination, figuring one thing to be another. An allegory requires no fuch operation, nor is one thing figured to be another: it confifts in choofing a fubject having properties or circumftances refembling thofe of the principal fubject; and the former is defcribed in fuch a manner as to reprefent the latter: the fubject thus reprefented is kept out of view: we are left to difcover it by reflection; and we are pleafed with the difcovery, becaufe it is our own work. (See the word ALLEGORY.) Quintilian gives the following inftance of an allegory,

O navis, referent in mare te novi
Fluctus. O quid agis? fortiter occupa portum.
Horat. lib. i. *ode* 14.

and explains it elegantly in the following words: "Totufque ille Horatii locus, quo navim pro republica, fluctuum tempeftates pro bellis civilibus, portum pro pace atque concordia, dicit."

In a *figure of fpeech*, there is no fiction of the imagination employed, as in a metaphor; nor a reprefentative fubject introduced, as in an allegory. This figure, as its name implies, regards the expreffion only, not the thought; and it may be defined, the ufing a word in a fenfe different from what is proper to it. Thus youth, or the beginning of life, is expreffed figuratively by *morning of life:* morning is the beginning of the day; and in that view it is employed to fignify the beginning of any other feries, life efpecially, the progrefs of which is reckoned by days. See FIGURE *of Speech*.

Metaphor and *allegory* are fo much connected, that it feemed proper to handle them together: the rules, particularly for diftinguifhing the good from the bad, are common to both. We fhall therefore proceed to thefe rules, after adding fome examples to illuftrate the nature of an *allegory*, which, with a view to this article, was but flightly illuftrated under its proper name.

Horace, fpeaking of his love to Pyrrha, which was now extinguifhed, expreffeth himfelf thus:

———Me tabulâ facer
Votivâ paries indicat uvida
Sufpendiffe potenti
Veftimenta maris Deo. *Carm. lib.* i. *ode* 5.

Again:

Phœbus volentem prælia me loqui,
Victas et urbes, increpuit lyrâ:
Ne parva Tyrrhenum per æquor
Vela darem. *Carm. lib.* v. *ode* 15.

Queen. Great Lords, wife men ne'er fit and wail their lofs,
But cheerly feek how to redrefs their harms.
What though the maft be now blown overboard,
The cable broke, the holding-anchor loft,
And half our failors fwallowed in the flood?
Yet lives our pilot ftill. Is't meet that he
Should leave the helm, and, like a fearful lad,
With tearful eyes add water to the fea,
And give more ftrength to that which hath too much;
While in his moan the fhip fplits on the rock,
Which induftry and courage might have fav'd?
Ah, what a fhame! ah, what a fault were this!
Third part Henry VI. *act* v. *fc.* 5.

Oroonoko. Ha! thou haft rous'd
The lion in his den; he ftalks abroad,
And the wide foreft trembles at his roar.
I find the danger now. *Oroonoko, act* iii. *fc.* 2.

"My well-beloved hath a vineyard in a very fruitful hill. He fenced it, gathered out the ftones thereof, planted it with the choiceft vine, built a tower in the midft of it, and alfo made a wine-prefs therein; he looked that it fhould bring forth grapes, and it brought forth wild grapes. And now, O inhabitants of Jerufalem, and men of Judah, judge, I pray you, betwixt me and my vineyard. What could have been done more to my vineyard, that I have not done? Wherefore, when I looked that it fhould bring forth grapes, brought it forth wild grapes? And now go to, I will tell you what I will do to my vineyard: I will take away the hedge thereof, and it fhall be eaten up; and break down the wall thereof, and it fhall be trodden down. And I will lay it wafte: it fhall not be pruned, nor digged, but there fhall come up briars and thorns: I will alfo command the clouds that they rain no rain upon it. For the vineyard of the Lord of hofts is the houfe of Ifrael, and the men of Judah his pleafant plant." *Ifaiah*, v. 1.

The rules that govern metaphors and allegories are of two kinds. The conftruction of thefe figures comes under the firft kind: the propriety or impropriety of introduction comes under the other.—To begin with rules of the firft kind; fome of which coincide with thofe already given for fimilies; fome are peculiar to metaphors and allegories:

In the firft place, it has been obferved, that a fimile cannot be agreeable where the refemblance is either too ftrong or too faint. This holds equally in metaphor and allegory; and the reafon is the fame in all. In the following inftances, the refemblance is too faint to be agreeable.

Malcolm.————But there's no bottom, none,
In my voluptuoufnefs: your wives, your daughters,
Your matrons, and your maids, could not fill up
The ciftern of my luft. *Macbeth, act* iv. *fc.* iv.

The beft way to judge of this metaphor, is to convert it into a fimile; which would be bad, becaufe there is fcarce any refemblance between luft and a ciftern, or betwixt enormous luft and a large ciftern.

Again:

He cannot buckle his diftemper'd caufe
Within the belt of rule. *Macbeth, Act* v. *fc.* 2.

There is no refemblance between a diftempered caufe and any body that can be confined within a belt.

Again:

Steep me in poverty to the very lips.
Othello, Act iv. *fc.* 9.

Poverty here muft be conceived a fluid, which it refembles not in any manner.

Metaphor. Speaking to Bolingbroke banifh'd for fix years:

> The fullen paffage of thy weary fteps
> Efteem a foil, wherein thou art to fet
> The precious jewel of thy home-return.
> *Richard* II. *act* ii. *fc.* 6.

Again:

> Here is a letter, lady,
> And every word in it a gaping wound
> Iffuing life-blood.
> *Merchant of Venice, Act* iii. *fc.* 3.

> Tantæ *molis* erat Romanam condere gentem.
> *Æneid.* i. 37.

The following metaphor is ftrained beyond all endurance: Timur-bec, known to us by the name of *Tamerlane the Great*, writes to Bajazet emperor of the Ottomans in the following terms:

" Where is the monarch who dares refift us? where is the potentate who doth not glory in being numbered among our attendants? As for thee, defcended from a Turcoman failor, fince the veffel of thy unbounded ambition hath been wreck'd in the gulf of thy felf-love, it would be proper, that thou fhouldft take in the fails of thy temerity, and caft the anchor of repentance in the port of fincerity and juftice, which is the port of fafety; left the tempeft of our vengeance make thee perifh in the fea of the punifhment thou deferveft."

Such ftrained figures, as obferved above, are not unfrequent in the firft dawn of refinement: the mind in a new enjoyment knows no bounds, and is generally carried to excefs, till tafte and experience difcover the proper limits.

Secondly, Whatever refemblance fubjects may have, it is wrong to put one for another, where they bear no mutual proportion. Upon comparing a very high to a very low fubject, the fimile takes on an air of burlefque: and the fame will be the effect, where the one is imagined to be the other, as in a metaphor; or made to reprefent the other, as in an allegory.

Thirdly, Thefe figures, a metaphor efpecially, ought not to be crowded with many minute circumftances; for in that cafe it is fcarcely poffible to avoid obfcurity. A metaphor above all ought to be fhort: it is difficult, for any time, to fupport a lively image of a thing being what we know it is not; and for that reafon, a metaphor drawn out to any length, inftead of illuftrating or enlivening the principal fubject, becomes difagreeable by overftraining the mind. Here Cowley is extrememely licentious: take the following inftance.

> Great and wife conqu'ror, who, where-e'er
> Thou com'ft, doft fortify, and fettle there!
> Who canft defend as well as get;
> And never hadft one quarter beat up yet;
> Now thou art in, thou ne'er will part
> With one inch of my vanquifh'd heart;
> For fince thou tookft it by affault from me,
> 'Tis garrifon'd fo ftrong with thoughts of thee
> It fears no beauteous enemy.

For the fame reafon, however agreeable long allegories may at firft be by their novelty, they never afford any lafting pleafure: witnefs the *Fairy Queen*, which with great power of expreffion, variety of images, and melody of verfification, is fcarce ever read a fecond time.

In the fourth place, the comparifon carried on in a fimile, being in a metaphor funk by imagining the principal fubject to be that very thing which it only refembles; an opportunity is furnifhed to defcribe it in terms taken ftrictly or literally with refpect to its imagined nature. This fuggefts another rule, That in conftructing a metaphor, the writer ought to make ufe of fuch words only as are applicable literally to the imagined nature of his fubject: figurative words ought carefully to be avoided; for fuch complicated figures, inftead of fetting the principal fubject in a ftrong light, involve it in a cloud; and it is well if the reader, without rejecting by the lump, endeavour patiently to gather the plain meaning, regardlefs of the figures:

> A ftubborn and unconquerable flame
> Creeps in his veins, and drinks the ftreams of life.
> *Lady Jane Gray, act* i. *fc.* 1.

Copied from Ovid,

> Sorbent avidæ præcordia flammæ.
> *Metarmorph. lib.* ix. 172.

Let us analyfe this expreffion. That a fever may be imagined a flame, we admit; though more than one ftep is neceffary to come at the refemblance: a fever, by heating the body, refembles fire; and it is no ftretch to imagine a fever to be a fire: again, by a figure of fpeech, flame may be put for fire, becaufe they are commonly conjoined; and therefore a fever may be termed a *flame*. But now, admitting a fever to be a flame, its effects ought to be explained in words that agree literally to a flame. This rule is not obferved here; for a flame drinks figuratively only, not properly.

King Henry to his fon prince Henry:

> Thou hid'ft a thoufand daggers in thy thoughts,
> Which thou haft whetted on thy ftony heart
> To ftab at half an hour of my frail life.
> *Second part Henry* IV. *act* iv. *fc.* 11.

Such faulty metaphors are pleafantly ridiculed in the *Rehearfal:*

" *Phyfician.* Sir, to conclude, the place you fill has more than amply exacted the talents of a wary pilot; and all thefe threatening ftorms, which, like impregnate clouds, hover o'er our heads, will, when they once are grafp'd but by the eye of reafon, melt into fruitful fhowers of bleffings on the people.

" *Bayes.* Pray mark that allegory. Is not that good?

" *Johnfon.* Yes, that grafping of a ftorm with the eye is admirable." *Act* ii. *fc.* 1.

Fifthly, The jumbling different metaphors in the fame fentence, beginning with one metaphor and ending with another, commonly called a *mixt metaphor*, ought never to be indulged.

> *K. Henry.*——Will you again unknit
> This churlifh knot of all-abhorred war,
> And move in that obedient orb again,
> Where you did give a fair and natural light?
> *Firft part Henry* VI. *act* v. *fc.* 1.

> Whether 'tis nobler in the mind, to fuffer
> The ftings and arrows of outrageous fortune;
> Or to take arms againft a fea of troubles,
> And by oppofing end them.
> *Hamlet, act* iii. *fc.* 2.

In the fixth place, It is unpleafant to join different metaphors in the fame period, even where they are preferved

preserved diſtinct: for when the ſubject is imagined to be firſt one thing and then another in the ſame period without interval, the mind is diſtracted by the rapid tranſition; and when the imagination is put on ſuch hard duty, its images are too faint to produce any good effect:

At regina gravi jamdudum ſaucia cura,
Vulnus alit venis, et cæco carpitur igni.
Æneid. iv. 1.

——————Eſt mollis flamma medullas
Interea, et tacitum vivit ſub pectore vulnus.
Æneid. iv. 66.

Motum ex Metello conſule civicum,
Bellique cauſas, et vitia, et modos,
Ludumque fortunæ, graveſque
Principum amicitias, et arma
Nondum expiatis uncta cruoribus,
Periculoſæ plenum opus aleæ,
Tractas, et incedis per ignes
Suppoſitos cineri doloſo.
Horat. Carm. lib. ii. *ode* 1.

In the laſt place, It is ſtill worſe to jumble together metaphorical and natural expreſſion, ſo as that the period muſt be underſtood in part metaphorically in part literally; for the imagination cannot follow with ſufficient eaſe changes ſo ſudden and unprepared: a metaphor begun and not carried on, hath no beauty; and inſtead of light, there is nothing but obſcurity and confuſion. Inſtances of ſuch incorrect compoſition are without number: we ſhall, for a ſpecimen, ſelect a few from different authors.

Speaking of Britain.

This precious ſtone ſet in the ſea,
Which ſerves it in the office of a wall,
Or as a moat defenſive to a houſe
Againſt the envy of leſs happier lands.
Richard II. *act* ii. *ſc.* 1.

In the firſt line Britain is figured to be a precious ſtone: in the following lines, Britain, diveſted of her metaphorical dreſs, is preſented to the reader in her natural appearance.

Theſe growing feathers pluck'd from Cæſar's wing,
Will make him fly an ordinary pitch,
Who elſe would ſoar above the view of men,
And keep us all in ſervile fearfulneſs.
Julius Cæſar, act i. *ſc.* 1.

Rebus anguſtis animoſus atque
Fortis adpare: ſapienter idem
Contrahes vento nimium ſecundo
Turgida vela. *Hor.*

The following is a miſerable jumble of expreſſions, ariſing from an unſteady view of the ſubject, between its figurative and natural appearance:

But now from gath'ring clouds deſtruction pours,
Which ruins with mad rage our halcyon hours:
Miſts from black jealouſies the tempeſt form,
Whilſt late diviſions reinforce the ſtorm.
Diſpenſary, canto iii.

To thee the world its preſent homage pays,
The harveſt early, but mature the praiſe.
Pope's imitation of Horace, B. ii.

Oui, ſa pudeur ne'ſt que franche grimace,
Qu'une ombre de vertu qui garde mal la place,
Et qui s'evanouit, comme l'on peut ſavoir,
Aux rayons du ſoleil qu'une bourſe fait voir.
Moliere, L'Etourdi, act iii. *ſc.* 2.

Et ſon ſeu, depourvû de ſenſe et de lecture,
S'éteint à chaque pas, faut de nourriture.
Boileau, L'art poetique, chant. iii. l. 319.

Dryden, in his dedication of the tranſlation of *Juvenal*, ſays, "When thus, as I may ſay, before the uſe of the loadſtone, or knowledge of the compaſs, I was ſailing in a vaſt ocean, without other help than the pole-ſtar of the ancients, and the rules of the French ſtage among the moderns, &c."

"There is a time when factions, by the vehemence of their own fermentation, ſtun and diſable one another."
Bolingbroke.

This fault of jumbling the figure and plain expreſſion into one confuſed maſs, is not leſs common in allegory than in metaphor. Take the following examples.

——————Heu! quoties fidem,
Mutatoſque Deos flebit, et aſpera
Nigris æquora ventis
Emirabitur inſolens,
Qui nunc te fruitur credulus aureâ:
Qui ſemper vacuam, ſemper amabilem
Sperat, neſcius auræ
Fallacis. *Horat. Carm. lib.* i. *ode* 5.

Pour moi ſur cette mer, qu'ici bas nous courons,
Je ſonge à me pourvoir d'eſquif et d'avirons,
A regler mes deſirs, à prévenir l'orage,
Et ſauver, s'il ſe peut, ma Raiſon du naufrage.
Boileau, epitre 5.

Lord Halifax, ſpeaking of the ancient fabuliſts: "They (ſays he) wrote in ſigns, and ſpoke in parables: all their fables carry a double meaning: the ſtory is one, and entire; the characters the ſame throughout; not broken or changed, and always conformable to the nature of the creature they introduce. They never tell you, that the dog which ſnapped at a ſhadow, loſt his troop of horſe; that would be unintelligible. This is his (Dryden's) new way of telling a ſtory, and confounding the moral and the fable together." After inſtancing from the hind and panther, he goes on thus: "What relation has the hind to our Saviour? or what notion have we of a panther's Bible? If you ſay he means the church, how does the church feed on lawns, or range in the foreſt? Let it be always a church, or always a cloven-footed beaſt; for we cannot bear his ſhifting the ſcene every line."

A few words more upon allegory. Nothing gives greater pleaſure than this figure, when the repreſentative ſubject bears a ſtrong analogy, in all its circumſtances, to that which is repreſented: but the choice is ſeldom ſo lucky; the analogy being generally ſo faint and obſcure, as to puzzle and not pleaſe. An allegory is ſtill more difficult in painting than in poetry: the former can ſhow no reſemblance but what appears to the eye; the latter hath many other reſources for ſhowing the reſemblance. And therefore, with reſpect to what the Abbé du Bos terms *mixt allegorical compoſitions*, theſe may do in poetry; becauſe, in writing, the allegory can eaſily be diſtinguiſhed from the hiſtorical part: no perſon, for example, miſtakes Virgil's Fame for

for a real being. But ſuch a mixture in a picture is intolerable; becauſe in a picture the objects muſt appear all of the ſame kind, wholly real or wholly emblematical. For this reaſon, the hiſtory of Mary de Medicis, in the palace of Luxembourg, painted by Rubens, is unpleaſant by a perpetual jumble of real and allegorical perſonages, which produce a diſcordance of parts, and an obſcurity upon the whole: witneſs, in particular, the tablature repreſenting the arrival of Mary de Medicis at Marſeilles; where, together with the real perſonages, the Nereids and Tritons appear ſounding their ſhells: ſuch a mixture of fiction and reality in the ſame group, is ſtrangely abſurd. The picture of Alexander and Roxana, deſcribed by Lucian, is gay and fanciful; but it ſuffers by the allegorical figures. It is not in the wit of man to invent an allegorical repreſentation deviating farther from any ſhadow of reſemblance, than one exhibited by Lewis XIV. anno 1664; in which an enormous chariot, intended to repreſent that of the ſun, is dragged along, ſurrounded with men and women, repreſenting the four ages of the world, the celeſtial ſigns, the ſeaſons, the hours, &c.; a monſtrous compoſition, and yet ſcarce more abſurd than Guido's tablature of Aurora.

In an allegory, as well as in a metaphor, terms ought to be choſen that properly and literally are applicable to the repreſentative ſubject: nor ought any circumſtance to be added that is not proper to the repreſentative ſubject, however juſtly it may be applicable properly or figuratively to the pricipal. The following allegory is therefore faulty.

Ferus et Cupido,
Semper ardentes acuens ſagittas
Cote *cruentâ*. *Horat. lib.* ii. *ode* 8.

For though blood may ſuggeſt the cruelty of love, it is an improper or immaterial circumſtance in the repreſentative ſubject: water, not blood, is proper for a whetſtone.

We proceed to the next head, which is, to examine in what circumſtrnces theſe figures are proper, in what improper. This inquiry is not altogether ſuperſeded by what is ſaid upon the ſame ſubject in the article COMPARISON; becauſe, upon trial, it will be foud, that a ſhort metaphor or allegory may be proper, where a ſimile, drawn out to a greater length and in its nature more ſolemn, would ſcarce be reliſhed.

And, in the firſt place, a metaphor, like a ſimile, is excluded from common converſation, and from the deſcription of ordinary incidents.

Second, in expreſſing any ſevere paſſion that totally occupies the mind, metaphor is unnatural.

The following example, of deep deſpair, beſide the highly figurative ſtyle, hath more the air of raving than of ſenſe:

Caliſta. Is it the voice of thunder, or my father?
Madneſs! Confuſion! let the ſtorm come on,
Let the tumultuous roar drive all upon me,
Daſh my devoted bark; ye ſurges, break it;
'Tis for my ruin that the tempeſt riſes.
When I am loſt, ſunk to the bottom low,
Peace ſhall return, and all be calm again.
Fair Penitent, act 4.

The following metaphor is ſweet and lively; but it ſuits not the fiery temper of Chamont, inflamed with paſſion: parables are not the language of wrath venting itſelf without reſtraint:

Chamont. You took her up a little tender flower,
Juſt ſprouted on a bank, which the next froſt
Had nipp'd; and with a careful loving hand,
Tranſplanted her into your own fair garden,
Where the ſun always ſhines: there long ſhe flouriſh'd,
Grew ſweet to ſenſe, and lovely to the eye;
Till at the laſt a cruel ſpoiler came,
Cropt this fair roſe, and rifled all its ſweetneſs,
Than caſt it like a loathſome weed away.
Orphan, act 4.

The following ſpeech, full of imagery, is not natural in grief and dejection of mind.

Gonſalez. O my ſon! from the blind dotage
Of a father's fondneſs theſe ills aroſe.
For thee I've been ambitious, baſe and bloody:
For thee I've plung'd into this ſea of ſin;
Stemming the tide with only one weak hand,
While t'other bore the crown, (to wreathe thy brow),
Whoſe weight has ſunk me ere I reach'd the ſhore.
Mourning Bride, act 5. *ſc* 6.

There is an enchanting picture of deep diſtreſs in Macbeth, where Macduff is repreſented lamenting his wife and children, inhumanly murdered by the tyrant. Stung to the heart with the news, he queſtions the meſſenger over and over: not that he doubted the fact, but that his heart revolted againſt ſo cruel a misfortune. After ſtruggling ſome time with his grief, he turns from his wife and children to their ſavage butcher; and then gives vent to his reſentment, but ſtill with manlineſs and dignity:

O, I could play the woman with mine eyes,
And braggart with my tongue. But, gentle Heav'n!
Cut ſhort all intermiſſion; front to front
Bring thou this fiend of Scotland and myſelf;
Within my ſword's length ſet him.——If he 'ſcape,
Then Heav'n forgive him too.

Metaphorical expreſſion, indeed, may ſometimes be uſed with grace where a regular ſimile would be intolerable: but there are ſituations ſo ſevere and diſpiriting, as not to admit even the ſlighteſt metaphor. It requires great delicacy of taſte to determine with firmneſs, whether the preſent caſe be of that nature: perhaps it is; yet who could wiſh a ſingle word of this admirable ſcene altered?

But metaphorical language is proper when a man ſtruggles to bear with dignity or decency a misfortune however great; the ſtruggle agitates and animates the mind:

Wolſey. Farewell, a long farewell, to all my greatneſs!
This is the ſtate of man; to-day he puts forth
The tender leaves of hope; to-morrow bloſſoms,
And bears his bluſhing honours thick upon him;
The third day comes a froſt, a killing froſt,
And when he thinks, good eaſy man, full ſurely
His greatneſs is a ripening, nips his root,
And then he falls as I do.
Henry VIII. *act* 3. *ſc.* 6.

METAPHRAST, a tranſlator, or perſon who renders an author into another form or another language, word for word.

METAPHYSICS.

METAPHYSICS.

METAPHYSICS is that part of philofophy which confiders the nature and properties of thinking beings.

Ariftotle, after treating on phyfics, begins his next book, (in which he pretends to elevate the mind above corporeal objects, to fix it on the contemplation of God, of angels, and of things fpiritual, and to enable it to judge of the principles of fciences by abftraction,) with the Greek words μετα τα φυσικα, *poft phyficam*, i. e. *after phyfics*. His difciples, and fucceeding philofophers, have formed, of thefe two, one word, METAPHYSICS, by which they mean that fcience of which we have juft now given the definition.

Metaphyfics is divided, according to the objects that it confiders, into fix principal parts, which are called, 1. *Ontology*. 2. *Cofmology*. 3. *Anthrophology*. 4. *Pfychology*. 5. *Pneumatology*: and, 6. *Theodicy*, or *metaphyfical theology*.

1. The doctrine that is named *ontology*, is that part of metaphyfics which inveftigates, and explains, the nature and general effence of all beings, as well as the qualities and attributes that effentially appertain to them, and which we ought to affign them by abftraction, as confidering them *à priori*. Hence it appears, that this doctrine fhould proceed in its operations from the moft fimple ideas; fuch as do not admit of any other qualities of which they may be compounded. Thefe fimple ideas are, for example, thofe of being, of effence, of fubftance, of mode, of exiftence as well with regard to time as place, of a neceffary caufe, of unity, the idea of negation, the difference between a being that is fimple or compound, neceffary or accidental, finite or infinite; the idea of effential and abftract properties, as of the greatnefs, perfection, and goodnefs of beings; and fo of the reft. The bufinefs therefore of ontology, is to make us acquainted with every kind of being in its effence and abftract qualities, and fuch as are diftinct from all other beings. This knowledge being once eftablifhed on fimple principles, juft confequences may from thence be drawn, and thofe things proved after which metaphyfics inquires, and which is its bufinefs to prove.

It is eafy to conceive, that even a clear knowledge of beings, and their effential properties, would be ftill defective and ufelefs to man, if he did not know how to determine and fix his ideas by proper denominations, and confequently to communicate his perceptions to thofe whom he would inftruct, or againft whom he is obliged to difpute, as they would not have the fame perceptions that he has. It is, by the way, perhaps, one of the greateft advantages that we have over other animals, to be able fo to determine our ideas by figns or denominations, either of writing or fpeech, as to refer each particular perception to its general idea, and each general perception to its particular idea. To render therefore our ideas intelligible to others, we muft have determinate words or denominations for each being, and the qualities of each being; and ontology teaches us thofe terms which are fo neceffary to fix our ideas, and to give them the requifite perfpicuity and precifion, that we may not difpute about words when we endeavour to extend the fphere of our knowledge, or when we debate concerning the effence of an object, or endeavour to make it more evident. It is for this reafon that ontology was formerly regarded as a barren fcience, that confifted of technical terms only; as a mere terminology: whereas the beft modern philofophers make it a more fubftantial fcience, by annexing determinate ideas to thofe words, and the examination of thofe objects themfelves that thefe terms imply. But the misfortune is, to fpeak the truth, that in this ontologic determination there is ftill much uncertainty and fophiftry. For, in the firft place, we yet know of no metaphyfics where all the definitions are juft; and in the fecond place, the words that are employed in thefe definitions have always fomething equivocal in their meaning, and have confequently themfelves need of definitions; and in this manner we may recede to infinity, unlefs we recur to the firft impreffions that the fimple words have made in our minds, and the primitive ideas which they there excite. The words *man*, *love*, *coach*, &c. fay more, and make a ftronger impreffion, than all the definitions we can give of them; by ontologic explications they are almoft always covered with a dark cloud.

2. Metaphyfics, after having, in as folid a manner as poffible, explained and eftablifhed the principles above-mentioned, continues its inquiries to the fecond part, that is called *Cofmology*, and examines into the effence of the world, and all that it contains; its eternal laws; of the nature of matter; of motion; of the nature of tangible bodies, of their attributes and effential qualities, and of all that can be known by abftraction, and fometimes alfo by adding the lights that man acquires concerning them by the experience of his fenfes. It is alfo in cofmology that we examine the Leibnitzian fyftem; that is, whether God in creating the world muft neceffarily have created the beft world; and if this world be fo in effect. And in this manner they purfue the argument from confequence to confequence to its laft refort. All philofophers, however, do not go equally deep. Each mind has its dofe of penetration. Due care fhould be likewife taken, that fubtilty, in this chain of reafoning, carried beyond the general bounds of the human mind, do not prejudice either the perfpicuity or the truth of ideas: feeing that error here too nearly approaches the truth; and that every idea, which cannot be rendered intelligible, is in effect equal to a falfe idea.

3. *Anthrophology*, or the knowledge of man, forms the third branch of metaphyfics. It is fubdivided into two parts. The firft, which confifts in the knowledge of the exterior parts of the human frame, does not belong to this fcience: anatomy and phyfiology teach that. The bufinefs here is only a metaphyfical examination of man, his exiftence, his effence, his effential qualities and neceffary attributes, all confidered *à priori*: and this examen leads at the fame time to

4. *Pyfychology*, which confifts in the knowledge of the foul in general, and of the foul of man in particu-

General View.

lar; concerning which the moſt profound, the moſt ſubtle and abſtract reſearches have been made, that the human reaſon is capable of producing; and concerning the ſubſtance of which, in ſpite of all theſe efforts, it is yet extremely difficult to aſſert any thing that is rational, and ſtill leſs any thing that is poſitive and well ſupported.

5. The fifth part of metaphyſics is called *pneumatology*. It is not a very long time ſince this term has been invented, and that metaphyſicians have made of it a diſtinct doctrine. By this they mean the knowledge of all ſpirits, angels, &c. It is eaſy to conceive that infinite art is neceſſary to give an account of what we do not abſolutely know any thing, and of which, by the nature of the ſubject itſelf, we never can know any thing. But the metaphyſician preſently offers to ſhow us, "what is the idea of a ſpirit; the effective exiſtence of a ſpirit; what are its general qualities and properties; that there are rational ſpirits, and that theſe rational ſpirits have qualities that are founded in the moral qualities of God:" for this is, in ſo many words, what is taught us by pneumatology.

6. *Metaphyſical Theology*, which M. Leibnitz and ſome others call *Theodicy*, is the ſixth and laſt doctrine of metaphyſics. It teaches us the knowledge of the exiſtence of God; to make the moſt rational ſuppoſitions concerning his divine eſſence, and to form a juſt idea of his qualities and perfections, and to demonſtrate them by abſtract reaſoning *à priori*. Theodicy differs from natural theology, in as much as this laſt borrows, in fact, from theodicy proofs and demonſtrations to confirm the exiſtence of a Supreme Being; but after having ſolidly eſtabliſhed that great truth, by extending its conſequences, natural theology teaches us what are the relations and connexions that ſubſiſt between that Supreme Being and man, and what are the moral duties that reſult from that connexion. As pneumatology is a ſcience highly inſidious and chimerical, ſo is metaphyſical theology ſuſceptible of ſound argument and demonſtration; to the great comfort of mankind, the whole of whoſe happineſs is founded on the certainty of this ſcience. If the effects and operations of ſpirits in the univerſe were as evident as the effects and operations of the Deity, and their neceſſary exiſtence as capable of being proved *à priori*, pneumatology would be a doctrine of equal certainty with theodicy: but as neither one nor the other can be proved with regard to ſpirits in general, whilſt God manifeſts himſelf in every part of nature, we have only to deſcend from the moſt ſimple and abſtract ideas, to thoſe that are the moſt compound; and from thence to reaſcend, by a chain of reaſonings, from the creature up to the Author of the creature and of all nature: we ſhall find, that the reſult of all theſe operations of the mind will conſtantly be, The neceſſity of the exiſtence of a God; and we may at all times determine, tho' very imperfectly, from the weakneſs of our diſcernment, what that Supreme Being muſt be, by poſitively determining what he cannot be. Every thing that can concur to furniſh new proofs on this ſubject, or to elucidate and eſtabliſh thoſe which are already known, is therefore of ineſtimable value to mankind: and though this were the only object of metaphyſics, it would highly merit the attention of thoſe of the moſt refined and moſt exalted genius.

After giving this general view of the ſubject, we ſhall proceed to give the ſubſtance of what Mr Locke has delivered upon it.

Of Ideas.

Sect. I. *Of Ideas in general, and their Original.*

7. By the term *idea*, as defined by Mr Locke, is meant whatever is the object of the underſtanding when a man thinks, or whatever it is which the mind can be employed about in thinking.

8. In order to trace the manner by which we acquire theſe ideas, let us ſuppoſe the mind to be, as we ſay, *white paper*, void of all characters, without any *ideas*: how comes it to be furniſhed? whence has it all the materials of reaſon and knowledge? From *experience* and *obſervation*. This, when employed about external ſenſible objects, we may call *ſenſation*: by this we have the ideas of *bitter*, *ſweet*, *yellow*, *hard*, &c. which are commonly called *ſenſible qualities*, becauſe conveyed into the mind by the ſenſes. The ſame experience, when employed about the internal operations of the mind, perceived and reflected on by us, we may call *reflection*: hence we have the *ideas* of *perception*, *thinking*, *doubting*, *willing*, *reaſoning*, &c.

9. Theſe two, viz. *external material things* as the objects of ſenſation, and *the operations of our own minds* as the objects of reflection, are the only *originals* from whence all our *ideas* take their beginnings: the underſtanding ſeems not to have the leaſt glimmering of *ideas* which it doth not receive from one of theſe two *ſources*. Theſe, when we have taken a full ſurvey of them, and their ſeveral *modes* and compoſitions, we ſhall find to contain our whole ſtock of *ideas*: and that we have nothing in our minds which did not come in one of theſe two ways.

10. It is evident, that children come by degrees to be furniſhed with *ideas* from the objects they are converſant with: they are ſo ſurrounded with bodies that perpetually and diverſely affect them, that ſome ideas will (whether they will or no) be imprinted on their minds. *Light* and *colours*, *ſounds* and *tangible* qualities, do continually ſolicit their proper ſenſes, and force an entrance into the mind. It is late, commonly, before *children* come to have *ideas* of the operations of their minds; and ſome men have not any very clear or perfect *ideas* of the greateſt part of them all their lives: becauſe, tho' they paſs there continually, yet, like floating viſions, they make not deep impreſſions enough to leave in the mind clear and laſting *ideas*, till the underſtanding turns inward upon itſelf, and reflects on its own operation, and makes them the objects of its own contemplation.

11. When a man *firſt perceives*, then he may be ſaid *to have ideas*; having ideas, and perception, ſignifying the ſame thing.

Sect. II. *Of Simple Ideas.*

Of ideas, ſome are *ſimple*, others *complex*. A *ſimple idea* is one uniform appearance or conception in the mind, which is not diſtinguiſhable into different *ideas*. Such are the *ideas* of *ſenſible qualities*, which though they are in the things themſelves ſo united and blended, that there is no ſeparation, no diſtance between them, yet the *ideas* they produce in the mind enter by the ſenſes ſimple and unmixed. Thus, tho' the

Different sorts of Ideas.

the hand feels *softness* and *warmth* in the same piece of *wax*, yet the *simple ideas* thus united in the same subject are as perfectly *distinct* as those that come in by different senses.

12. These *simple ideas* are suggested no other way than from the two ways above-mentioned, viz. *sensation* and *reflection*.

13. The mind being once stored with the *simple ideas*, has the power to repeat, compare, and unite them to an infinite variety; and so can make, at pleasure, new *complex ideas*. But the most enlarged understanding cannot frame one new *simple idea;* nor by any force destroy them that are there.

14. Ideas, with reference to the different ways wherein they approach the mind, are of *four sorts*.

First, There are some which come into our minds by *one sense* only.

Secondly, There are others conveyed into the mind by *more senses than one*.

Thirdly, Others that are had from *reflection* only.

Fourthly, There are some suggested to the mind by all the ways of *sensation* and *reflection*.

Sect. III. *Of Ideas of one Sense.*

15. Some ideas enter into the mind only by one sense peculiarly adapted to receive them. Thus colours, sounds, smells, &c. come in only by the eyes, ears, and nose. And if these organs are any of them so disordered as not to perform their functions, they have no other way to bring themselves in view, and be perceived by the understanding.

16. We shall here mention one, which we receive by our touch, because it is one of the chief ingredients in many of our complex ideas; and that is, the idea of *solidity:* it arises from the resistance one body makes to the entrance of another body into the place it possesses, till it has left it. There is no idea which we more constantly receive from sensation than this. In whatever posture we are, we feel somewhat that supports us, and hinders us from sinking downwards: and the bodies we daily handle, make us perrceive, that while they remain between them, they do, by an unsurmountable force, hinder the approach of the parts of our hands that press them. This seems to be the most essential property of body, and that whereby we conceive it to fill space: the idea of which is, that where we imagine any space taken up by a solid substance, we conceive it so to possess it, that it excludes all other solid substances. This resistance is so great, that no force can surmount it. All the bodies in the world pressing a *drop of water* on all sides, will never be able to overcome the resistance it makes to their approaching one another, till it be removed out of their way.

17. The idea of *solidity* is distinguished from that of *pure space*, in as much as this *latter* is neither capable of resistance nor motion: it is distinguished from *hardness*, in as much as hardness is a firm cohesion of the solid parts of matter making up masses of a sensible bulk, so that the whole doth not easily change its figure. Indeed, *hard* and *soft*, as commonly apprehended by us, are but *relative* to the constitutions of our bodies: that being called *hard* which will put us to pain sooner than change its figure by the pressure of any part of our bodies; and that *soft*, which changes the situation of its parts upon an easy and unpainful touch.

Sensation and Reflection.

18. This difficulty of changing situation among the parts, gives no more solidity to the hardest body than to the softest; nor is an adamant one jot more solid than water. He that shall fill a yielding soft body well with air or water, will quickly find its resistance. By this we may distinguish the idea of the extension of body, from the idea of the extension of space: That of body, is the cohesion or continuity of solid, separable, and moveable parts; that of space, the continuity of unsolid, inseparable, and immoveable parts. Upon the solidity of bodies depend their mutual impulse, resistance, and protrusion.

Sect. IV. *Of Simple Ideas of different Senses.*

19. Some ideas we get into the mind by *more than one sense;* as *space*, *extension*, *figure*, *rest*, and *motion*. These are perceivable by the eyes and touch.

Sect. V. *Of Simple Ideas of Reflection.*

20. Some ideas are had from reflection only. Such are the ideas we have of the operations of our minds: of which the two principal are, *perception*, or *thinking;* and *volition*, or *willing*. The powers of producing these operations are called *faculties;* which are, the *understanding*, and *will*. The several *modes* of thinking, &c. belong to this head.

Sect. VI. *Of Simple Ideas of Sensation and Reflection.*

21. There are some simple ideas conveyed into the mind by all the ways of *sensation* and *reflection;* such are *pleasure*, *pain*, *power*, *existence*, *unity*, *succession*. Pleasure or delight, pain or uneasiness, accompany almost every impression on our senses, and every action or thought of the *mind*.

22. The Author of our beings having given a power to our minds, in several instances, to choose amongst its ideas which it will think on; to excite us to these actions of *thinking* and *motion*, he has joined to several thoughts and sensations a perception of delight; without this we should have no reason to prefer one thought or action to another.

23. *Pain* has the same efficacy to set us on work that pleasure has; since we are as ready to avoid that, as to pursue this. This is worth our consideration, that *pain is often produced by the same objects and ideas that produce pleasure* in us. This their near conjunction gives us new occasion of admiring the wisdom and goodness of our *Maker;* who, designing the preservation of our being, has annexed pain to the application of many things to our bodies, to warn us of the harm they will do us, and as advices to withdraw us from them. But he not designing our preservation barely, but the preservation of every part and organ in its perfection, hath in many cases annexed pain to those very ideas which delight us. Thus heat, that is very agreeable to us in one degree, by a little greater increase of it proves no ordinary torment: Which is wisely ordered by *nature*, that when any object does by the vehemence of its operation disorder the instruments of sensation, whose structures cannot but be very delicate, we might by the pain be warned to withdraw before the organ be quite put out of order. That this is the *end of pain*, appears from this consideration;

Simple Ideas.

deration; that though great light is insufferable to the eyes, yet the highest degree of *darkness* does not at all disease them, because *that* causes no disorderly motion in that curious organ the eye. But excess of *cold*, as well as *heat*, pains us; because it is equally destructive to the temper which is necessary to the preservation of life.

24. *Existence* and *unity* are two other ideas suggested by every object without, and every idea within. When ideas are in our minds, we consider them as being actually there, as well as we consider things to be actually without us; which is, that they *exist*, or have existence: And whatever we consider as *one thing*, whether a *real being*, or *idea*, suggests the idea of *unity*.

25. *Power* is another idea derived from these sources: For finding in ourselves that we can *think*, and *move* several parts of our bodies at pleasure, and observing the *effects* that natural bodies produce in one another; by both these ways we get the idea of *power*.

26. *Succession* is another idea suggested by our senses, and by reflection on what passes in our minds: For if we look into ourselves, we shall find our *ideas* always, whilst we are awake, or have any thought, passing in train, one going and another coming, without intermission.

Sect. VII. *Some farther Considerations concerning Simple Ideas.*

27. Whatsoever is able, by affecting our senses, to cause any perception in the mind, doth hereby produce in the understanding a *simple idea;* which, whatsoever be the cause of it, is looked upon as a *real positive idea* in the understanding. Thus the ideas of *heat* and *cold*, *light* and *darkness*, *motion* and *rest*, &c. are equally positive in the mind, though some of their causes may be mere *privations*.

28. That a *privative* cause may produce a *positive* idea, appears from shadows; which, though nothing but the absence of light, are discernible, and cause clear and positive ideas. We have indeed some *negative* names which stand not directly for positive ideas, but of their absence; such as *insipid*, *silence*, which denote positive ideas, viz. *taste* and *sound*, with a signification of their absence.

29. It will be useful to distinguish *ideas* as they are *perceptions* in our minds, from what *they are in the bodies* that cause such perceptions in us; for we are not to think the former exact images and resemblances of something inherent in the subject, most of those of *sensation* being, in the mind, no more the likeness of something existing without us, than the names that stand for them are the likeness of our ideas, which yet, upon hearing, they excite in us.

30. Whatsoever the *mind perceives in itself*, or is the immediate object of perception, thought, or understanding, is an idea: And the power to produce any idea in our mind, is the *quality of the subject* wherein that power exists. Thus a *snow-ball* having the power to produce in us the ideas of *white*, *cold*, and *round;* those *powers*, as they are in the snow-ball, are called *qualities;* and as they are *sensations* or *perceptions* in our understandings, they are called *ideas*. These *qualities* are of *two sorts:*

31. First, *Original*, or primary; such are *solidity*, *extension*, *motion*, or *rest*, *number*, and *figure*. These are inseparable from body, and such as it constantly keeps in all its changes and alterations.

Perception.

32. Secondly, *Secondary qualities;* such as *colours*, *smells*, *tastes*, *sounds*, &c. which, whatever reality we by mistake may attribute to them, are in truth nothing in the objects themselves, but *powers* to produce various sensations in us; and depend on the qualities beforementioned.

33. The *ideas* of *primary* qualities of bodies, are resemblances of them; and their patterns really exist in bodies themselves: But the ideas produced in us by secondary qualities have no resemblance of them at all; and what is *sweet*, *blue*, or *warm*, in the idea, is but the certain bulk, figure, and motion of the sensible parts in the bodies themselves, which we call so.

34. Thus we see, that fire at one distance produces in us the sensation of *warmth*, which at a nearer approach causes the sensation of *pain*. Now what reason have we to say, that the idea of *warmth* is actually in the fire, but that of *pain* not in the fire, which the same fire produces in us the same way? The bulk, number, figure, and motion of the parts of fire, are really in it, whether we perceive them or not; and therefore may be called *real* qualities, because they really exist in that body: But *light* and *heat* are no no more really in it, than sickness or pain: Take away the sensation of them; let not the eyes see light or colours, nor the ear hear sounds; let the palate not taste, or the nose smell; and all *colours*, *tastes*, *odours*, and *sounds*, as they are such particular ideas, vanish and cease, and are reduced to their causes, that is, bulk, motion, figure, &c. of parts.

35. These *secondary* qualities are of two sorts. First, *Immediately perceivable:* which by immediately operating on our bodies, produce several different ideas in us. Secondly, *Mediately perceivable;* which, by operating on other bodies, change their primary qualities, so as to render them capable of producing ideas in us different from what they did before. These last are powers in bodies, which proceed from the particular constitution of those primary and original qualities, to make such a change in the *bulk*, *figure*, *texture*, &c. of another body, as to make it operate on our senses different from what it did before; as in fire, to make lead fluid. These two last being nothing but powers relating to other bodies, and resulting from the different modifications of the original qualities, are yet otherwise thought of; the former being esteemed *real qualities*, but the latter barely *powers*.

Sect. VIII. *Of Perception.*

36. Perception is the first idea we receive from reflection. It is by some called *thinking* in general: Though *thinking*, in the propriety of the *English* tongue, signifies that sort of operation of the mind about its ideas, wherein the mind is active; where it considers any thing with some degree of voluntary attention: For in bare *perception* the mind is, for the most part, only *passive;* and what it perceives, it cannot avoid perceiving. What this is, we cannot otherwise know, than by reflecting on what passes in our minds when we see, feel, hear, &c.

37. Im-

Retention. 37. Impreffions made on the outward parts, if they are not taken notice of within, caufe no *perception;* as we fee in thofe whofe minds are intently bufied in the contemplation of certain objects.

38. We may obferve, that the ideas we receive from fenfation, are often in grown people altered by the judgment, without our taking notice of it. Thus a globe of any uniform colour, as of gold or jet, being fet before our eyes, the *idea* thereby imprinted is of a flat circle varioufly fhadowed: But being accuftomed to perceive what kind of appearance convex bodies are wont to make in us, the judgment alters the appearance into their caufes; and, from that variety of fhadow or colour, frames to itfelf the perception of a convex figure of one uniform colour. This in many cafes, by a fetled habit, is performed fo readily, that we take that for the perception of our fenfation, which is but an idea formed by the judgment; fo that one ferves only to excite the other, and is fcarce taken notice of itfelf: As a man who reads or hears with attention, takes little notice of the characters or founds, but of the ideas that are excited in him by them.

39. Perception is alfo the firft ftep and degree towards knowledge, and the inlet of all the materials of it; fo that the fewer fenfes any man has, and the duller the impreffions that are made by them are, the more remote he is from that knowledge which is to be found in other men.

Sect. IX. *Of Retention.*

40. The next faculty of the mind whereby it makes a further progrefs towards knowledge, is called *retention;* which is the keeping of thofe ideas it has received. Which is done two ways:

41. *Firft*, By keeping the idea which is brought into the mind for fome time actually in view; which is called *contemplation.*

24. *Secondly*, By reviving thofe ideas in our minds which have difappeared, and have been, as it were, laid out of fight: And this is *memory;* which is, as it were, the ftore-houfe of our ideas; for the narrow mind of man not being capable of having many ideas under view at once, it was neceffary to have a repofitory to lay up thofe ideas, which at another time it may have ufe of. But our ideas being nothing but actual perceptions in the mind, which ceafe to be any thing when there is no perception of them, this laying up of our *ideas* in the repofitory of the memory fignifies no more but this, that the mind has a power, in many cafes, to revive perceptions it has once had, with this additional perception annexed to them, that it has had them before. And it is by the affiftance of this faculty, that we are faid to have all thofe ideas in our underftandings which we can bring in fight, and make the objects of our thoughts, without the help of thofe fenfible qualities which firft imprinted them there.

43. Thofe ideas that are often refrefhed by a frequent return of the objects or actions that produce them, fix themfelves beft in the memory, and remain longeft there: Such are the *original qualities of bodies.* viz. Solidity, extenfion, figure, motion, *&c.* Thefe and the like are feldom quite loft while the mind retains any *ideas* at all.

Sect. X. *Of Difcerning, and other Operations of the Mind.*

Complex Ideas.

44. Another faculty of the mind, is that of *difcerning between its ideas.* On this depends the evidence and certainty of feveral general propofitions. In being able nicely to diftinguifh one thing from another, where there is the leaft difference, confifts, in a great meafure, that *exactnefs of judgment* and *clearnefs of reafon* which is to be obferved in one man above another.

45. To the well diftinguifhing our *ideas*, it chiefly contributes that they be clear and determinate; and when they are fo, it will not breed any confufion or miftake about them, though the fenfes fhould convey them from the fame object differently on different occafions.

46. The comparing of our *ideas* one with another in refpect of *extent*, *degree*, *time*, *place*, or any other circumftances, is another operation of the mind about its *ideas*, which is the ground of *relations.* Brutes feem not to have this faculty in any great degree. They have probably feveral *ideas* diftinct enough; but cannot compare them farther than fome fenfible circumftances annexed to the objects themfelves.

47. *Compofition* is another operation of the mind, whereby it combines feveral of its fimple *ideas* into *complex* ones: Under which operation we may reckon that of *enlarging;* wherein we put feveral *ideas* together of the fame kind, as feveral units to make a *dozen.*

48. *Abftraction* is another operation of the mind, whereby the mind forms general *ideas* from fuch as it received from particular objects; which it does by confidering them, as they are in the mind fuch appearances feparate from the circumftances of real exiftence, as *time*, *place*, &c. Thefe become general *reprefentatives* of all the fame kind, and their names applicable to whatever exifts comformable to fuch abftract *ideas.* Thus the colour received from *chalk*, *fnow*, and *milk*, is made a reprefentative of all of that kind; and has a name given it (*whitenefs*), which fignifies the fame quality, wherever to be found or imagined. And thus *univerfals*, both *ideas* and *terms*, are made.

Sect. XI. *Of Complex Ideas.*

49. In the reception of fimple ideas the mind is only *paffive*, having no power to frame any one to itfelf, nor having any idea which does not wholly confift of them. But about thefe fimple ideas it exerts feveral acts of its own, whereby out of them, as the materials and foundations of the reft, the others are framed. The acts of the mind, wherein it exerts its power over its fimple ideas, are chiefly thefe three. *Firft*, It combines feveral fimple ideas into one compound one; and thus all *complex ideas* are made. *Secondly*, It brings two ideas, whether *fimple* or *complex*, together, and fets them by one another, fo as to take a view of them at once, without uniting them into one; by which way it gets all its ideas of relations. *Thirdly*, It feparates them from all other ideas that accompany them in their real exiftence: And thus all its *general ideas* are made. As *fimple ideas* are obferved to exift in feveral combinations united together, fo the mind may confider them as united, not only as they are really

Of Space. really united in external objects, but as itself has joined them. *Ideas* thus made up of several ones put together, are called *complex;* as *man*, *army*, *beauty*, *gratitude*, &c. By this faculty of repeating and joining together its *ideas*, the mind has great power in varying and multiplying the objects of its thoughts. But it is still confined to those simple *ideas* which it received from the two sources of *sensation* and *reflection*. It can have no other *ideas* of sensible qualities than what come from without by the senses, nor any other *ideas* of the operations of a thinking substance than what it finds in itself; but having once got these simple *ideas*, it can by its own power put them together, and make new *complex ones*, which it never received so united.

50. *Complex ideas*, however compounded and decompounded, though their number be infinite, and their variety endless, may all be reduced under these three heads: 1st, *Modes;* 2dly, *Substances;* 3dly, *Relations*.

51. First, *Modes* are such complex *ideas* as contain not the supposition of subsisting by themselves; but are considered as dependences on, and affections of, substances; as *triangle*, *gratitude*, *murder*, &c. These modes are of two sorts: First, *Simple;* which are combinations of the same simple *idea;* as a *dozen*, *score*, &c. which are but the *ideas* of so many distinct units put together. Secondly, *Mixed;* which are compounded of simple *ideas* of several kinds; as *beauty*, which consists in a certain composition of colour and figure, causing delight in the beholder; *theft*, which is the concealed change of the possession of any thing, without the consent of the proprietor. *These* visibly contain a combination of *ideas* of several kinds.

52. Secondly, *Substances*. The *ideas* of substances are only such combinations of simple *ideas*, as are taken to represent distinct particular things subsisting by themselves, in which the confused *idea* of substance is always the chief. Thus a combination of the *ideas* of a certain figure, with the powers of motion, thought, and reasoning, joined to substance, make the ordinary *idea* of man.

53. These again are either of *single substances*, as *man*, *stone;* or of *collective*, or several put together, as *army*, *heap*. *Ideas* of several substances thus put together, are as much each of them one single *idea*, as that of a *man* or an *unit*.

54. Thirdly, *Relations;* which consist in the consideration and comparing of one *idea* with another. Of these several kinds we shall treat in their order.

Sect. XII. *Of Simple Modes: And, first, of the simple modes of Space.*

55. Concerning *simple modes* we may observe, that the modifications of any *simple ideas* are as perfectly different and distinct ideas in the mind, as those of the greatest distance or contrariety: Thus *two* is as distinct from *three*, as *blueness* from *heat*.

56. *Space* is a simple idea which we get both by our sight and touch. When we consider it barely in length between two bodies, it is called *distance:* when in length, breadth, and thickness, it may be called *capacity*. When considered between the extremities of matter, which fills the capacity of space with something solid, tangible, and moveable, it is called *extension*. And thus *extension* will be an *idea* belonging to body; *space* may be conceived without it.

57. Each different *distance* is a different modification of space; and each *idea* of any different space is a *simple mode* of this *idea*. Such are an *inch*, *foot*, *yard*, &c. When these *ideas* are made familiar to mens thoughts, they can in their minds repeat them as often as they will, without joining to them the *idea* of body, and frame to themselves the *ideas* of feet, yards, or fathoms, beyond the utmost bounds of all bodies; and by adding these still one to another, enlarge their *idea* of space as much as they please. From this power of repeating any *idea* of distance, without being ever able to come to an end, we come by the *idea* of immensity.

58. Another modification of *space* is taken from the *relation* of the parts of the termination of extension or circumscribed space amongst themselves; and this is what we call *figure*. This the *touch* discovers in sensible bodies, whose extremities come within our reach; and the *eye* takes both from bodies and colours, whose boundaries are within its view; where observing how the extremities terminate either in straight lines, which meet at discernible angles, or in crooked lines, wherein no angles can be perceived; by considering these as they relate to one another in all parts of the extremities of any body or space, it has that idea we call *figure:* which affords to the mind infinite variety.

59. Another *mode* belonging to this head, is that of *place*. Our idea of *place* is nothing but the relative position of any thing with reference to its distance from some fixed and certain points. Whence we say, that a thing has or has not changed *place*, when its distance either is or is not altered with respect to those bodies with which we have occasion to compare it. That this is so, we may easily gather from hence, that we can have no idea of the place of the *universe*, though we can of all its parts. To say that the world is *somewhere*, means no more than that it does *exist*. The word *place* is sometimes taken to signify that *space* which any body takes up; and so the universe may be conceived in a place.

Sect. XIII. *Of Duration, and its Simple Modes.*

Duration.

60. There is another sort of *distance*, the *idea* of which we get from the fleeting and perpetually perishing parts of succession, which we call *duration*. The simple modes of it are any different lengths of it whereof we have distinct *ideas;* as *hours*, *days*, *years*, &c. *time* and *eternity*.

61. The *idea* of *succession* is got by reflecting on that train of *ideas* which constantly follow one another in our minds as long as we are awake. The distance between any parts of this *succession*, is what we call *duration;* and the continuation of the existence of ourselves, or any thing else, *commensurate* to the succession of any *ideas* in our minds, is what we call our *own duration*, or *that* of another thing co-existing with our thinking. That this is so, appears from hence, that we have no perception of succession or duration, when that succession of our *ideas* ceases, as in *sleep:* the moment that we sleep, and awake, how distant soever, seems to be joined and connected. And possibly it would be so to a waking man, could he fix upon one *idea* without variation and the succession of others. And we see that

they

Of Number.

they whose thoughts are very intent upon one thing, let slip out of their account a good part of that *duration*, and think that time shorter than it is. But if a man, during his sleep, *dream*, and a variety of *ideas* make themselves perceptible in his mind one after another, he hath then, during such dreaming, a sense of *duration*, and of the length of it.

A man having once got this *idea* of duration, can apply it to things which exist while he does not think: and thus we measure the time of our sleep, as well as that wherein we are awake.

Duration, as marked by certain periods and measures, is what we most properly call *time;* which we measure by the diurnal and annual *revolutions* of the sun, as being constant, regular, and universally observable by all mankind, and supposed equal to one another.

The mind having once got such a measure of *time*, as the annual revolution of the sun, can easily apply it to duration wherein that measure itself did not exist; and the *idea* of *duration* equal to an *annual revolution of the sun*, is as easily applicable in our thoughts to duration where no sun nor motion was, as the *idea* of a *foot* or *yard* to distances beyond the confines of the world.

By the same means, and from the same original that we come to have the *idea* of time, we have also that *idea* which we call *eternity:* for having got the ideas of certain lengths of duration, we can in our thoughts add them to one another as oft as we please, without ever coming to an end.

And thus it is plain, that from the two fountains of all knowledge before mentioned, *viz. sensation* and *reflection*, we get the ideas of duration, and the several measures of it.

Sect. XIV. *Of Number.*

62. The complex *ideas* of *number* are formed by adding several *units* together. The *simple modes* of it are each several combinations, as *two, three*, &c. These are of all others most distinct, the nearest being as clearly different from each other as the most remote: *two* being as distinct from *one*, as two hundred. But it is hard to form distinct *ideas* of every the least excess in extension. Hence demonstrations in numbers are more general in their use, and more determinate in their application, than those of extension.

63. *Simple modes* of numbers being in our minds but so many combinations of units, which have no variety but *more* or *less; names* for each distinct combination seem more necessary than in any other sort of *ideas:* For without a *name*, or *mark*, to distinguish that precise collection, it will hardly be kept from being a heap of confusion. Hence some *Americans* have no distinct *idea* of any number beyond twenty; so that when they are discoursed with of greater numbers, they shew the hairs of their head. So that to reckon right, two things are required.

64. *First*, That the mind distinguish carefully two *ideas* which are different one from another only by the addition or subtraction of one unit.

65. *Secondly*, That it retain in memory the names or marks of the several combinations, from an unit to that number; and that in exact order, as they follow one another. In either of which if it fails, the whole business of *numbering* will be disturbed; and there will remain only the confused *idea* of *multitude;* but the *ideas* necessary to distinct numeration will not be attained to.

Of Infinity.

Sect. XV. *Of Infinity.*

66. The *idea* signified by the name *infinity*, is best examined, by considering to *what* infinity is by the mind attributed, and then *how* it frames it. *Finite* and *infinite*, then, are looked upon as the modes of quantity; and attributed primarily to things that have parts, and are capable of increase or diminution by the *addition* or *subtraction* of any the least part. Such are the *ideas* of *space, duration*, and *number*.

67. When we apply this *idea* to the *Supreme Being*, we do it primarily, in respect of his duration and ubiquity; more figuratively, when to his *wisdom, power, goodness*, and other attributes, which are properly *inexhaustible* and *incomprehensible:* for when we call them infinite, we have no other *idea* of this infinity, but what carries with it some reflection on the *number* or the *extent* of the *acts* or *objects* of God's power and wisdom, which can never be supposed so great, or so many, that these attributes will not always surmount and exceed, though we multiply them in our thoughts with the infinity of *endless number*.

68. The next thing to be considered, is, *How we come* by the *idea* of infinity. Every one that has any *idea* of any stated lengths of space, as a *foot, yard*, &c. finds that he can repeat that *idea*, and join it to *another*, to a *third*, and so on without ever coming to an end of his additions. From this power of enlarging his *idea* of space, he takes the *idea* of infinite space, or *immensity*. By the same power of repeating the *idea* of any length of duration we have in our minds, with all the endless addition of number, we come by the *idea* of *eternity*.

69. If our *idea* of *infinity* be got by repeating without end our own *ideas;* why do we not attribute it to other *ideas*, as well as those of *space* and *duration;* since they may be as easily and as often repeated in our minds as the other? yet nobody ever thinks of infinite *sweetness* or *whiteness*, though he can repeat the *idea* of sweet or white as frequently as those of *yard* or *day*. But those *ideas* that have parts, and are capable of increase by the addition of any parts, afford us, by their repetition, an *idea* of infinity; because with the endless repetition there is continued an enlargement, of which there is no end. But it is not so in other *ideas:* for if to the perfect *idea* I have of white, I add another of equal whiteness, it enlarges not my *idea* at all. Those *ideas* that consist not of parts, cannot be augmented to what proportion men please, or be stretched beyond what they have received by their senses: but *space, duration*, and *number*, being capable of increase by repetition, leave in the mind an *idea* of an endless room for more; and so those *ideas* alone lead the mind towards the thought of infinity.

Sect. XVI. *Of the Modes of Thinking.*

70. When the mind turns its view inwards upon itself, *thinking* is the first *idea* that occurs: wherein it observes a great variety of modifications; and thereof frames to itself distinct *ideas*. Thus the perception annexed to any impression on the body made by an external

Pleasure and Pain.

ternal object, is called *sensation*. When an *idea* recurs without the presence of the object, it is called *remembrance:* when sought after by the mind, and brought again in view, it is *recollection:* when held there long under attentive consideration, it is *contemplation*. When *ideas* float in the mind without regard or reflection, it is called in French *reverie:* our language has scarce a name for it: When the ideas are taken notice of, and as it were registered in the memory, it is *attention*: When the mind fixes its view on any one *idea*, and considers it on all sides, it is *intention* and *study*. *Sleep*, without dreaming, is rest from all these: And *dreaming* is the perception of *ideas* in the mind, not suggested by any external objects, or known occasions; nor under any choice or conduct of the understanding.

Sect. XVII. *Of the Modes of Pleasure and Pain.*

71. Pleasure and *pain* are simple *ideas*, which we receive both from sensation and reflection. There are thoughts of the mind, as well as sensations, accompanied with pleasure or pain. Their causes are termed *good* or *evil*. *Pleasure* and *pain*, and their causes *good* and *evil*, are the hinges upon which our passions turn; by reflecting on the various modifications or tempers of mind, and the internal sensations which pleasure and pain, good and evil, produce in us, we may thence form to ourselves the *ideas* of our passions. Thus by reflecting upon the thought we have of the delight which any thing is apt to produce in us, we have an *idea* we call *love:* and on the contrary, the thought of the pain which any thing present or absent produces in us, is what we call *hatred*. *Desire* is that uneasiness which a man finds in himself upon the absence of any thing the present enjoyment of which carries the *idea* of delight with it. *Joy* is a delight of the mind arising from the present or assured approaching possession of a good. *Sorrow* is an uneasiness of the mind, upon the thought of a good lost, or the sense of a present evil. *Hope* is a pleasure in the mind, upon the thought of a probable future enjoyment of a thing which is apt to delight. *Fear* is an uneasiness of the mind, upon the thought of a future evil likely to befal us. *Anger* is a discomposure of the mind, upon the receipt of injury, with a present purpose of revenge. *Despair* is the thought of unattainableness of any good. *Envy* is an uneasiness of the mind, caused by the consideration of a good we desire, obtained by one we think should not have had it before us.

72. It is to be considered, that, in reference to the passions, the removal or lessening of a pain is considered and operates as a pleasure; and the loss or diminishing of a pleasure, as a pain: And farther, that the passions in most persons operate on the body, and cause various changes in it; but these being not always sensible, do not make a necessary part of the *idea* of each passion.

Sect. XVIII. *Of Power.*

73. The mind being every day informed by the senses of the alteration of those simple *ideas* it observes in things without, reflecting also on what passes within itself, and observing a constant change of its *ideas*, sometimes by the impressions of outward objects upon the senses, and sometimes by the determination of its own choice; and concluding, from what it has so constantly observed to have been, that the like changes will for the future be made in the same things, by the same agents, and by the like ways, considers in one thing the possibility of having any of its simple *ideas* changed, and in another the possibility of making that change, and so comes by that *idea* which we call *power*. Thus we say *fire* has a power to *melt gold*, and make it fluid; and *gold* has a power to be *melted*.

Of Power.

74. Power thus considered, is twofold, viz. as able to make, or able to receive any change: the one may be called *active*, the other *passive power*. Of *passive power* all sensible things abundantly furnish us with *ideas*, whose sensible qualities and beings we find to be in a continual flux. Nor have we of *active power* fewer instances; since whatever change is observed, the mind must collect a power somewhere able to make that change. But yet, if we will consider it attentively, bodies by our senses do not afford us so clear and distinct an *idea* of *active* power as we have from reflection on the operation of our minds. For all power relating to action, and there being but two sorts of *action*, viz. *thinking* and *motion*, let us consider whence we have the clearest *ideas* of the powers which produce these actions.

75. Of *thinking* body affords us no *idea* at all: it is only from reflection that we have that; neither have we from body any *idea* of the beginning of motion. A body at rest, affords us no *idea* of any *active* power to move; and when it is set in motion itself, that motion is rather a passion than action in it. The *idea* of the beginning of motion, we have only by reflection on what passes in ourselves; where we find by experience, that barely by willing it, we can move the parts of our bodies which were before at rest.

We find in ourselves a power to begin or forbear, continue or end, several actions of our minds, and motions of our bodies, barely by a thought, or preference of the mind. This power which the mind has thus to order the consideration of any *idea*, or the forbearing to consider it; or to prefer the motion of any part of the body to its rest, and *vice versa*, in any particular instance, is that we call the *will;* the actual exercise of that power is that which we call *volition* or *willing*. The forbearance or performance of that action, consequent to such order or command of the mind, is called *voluntary;* and whatsoever action is performed without such a thought of the mind, is called *involuntary*.

77. The power of perception is that we call the *understanding*. *Perception*, which we make the act of the understanding, is of three sorts: *1st*, The perception of *ideas* in our minds. *2dly*, The perception of the signification of signs. *3dly*, The perception of the agreement or disagreement of any distinct *ideas*. These powers of the mind, viz. of perceiving and preferring, are usually called by another name; and the ordinary way of speaking is, that the understanding and will are two *faculties* of the mind.

78. From the consideration of the extent of the power of the mind over the actions of the man, which every one finds in himself, arise the *ideas* of *liberty* and *necessity:* so far as a man has a power to think or not to think, to move or not to move, according to the preference or direction of his own mind, so far is a man free.

Of Power.

free. Wherever any performance or forbearance are not equally in a man's power; wherever doing, or not doing, will not equally follow upon the preference of his mind; there he is not *free*, though perhaps the action may be *voluntary*. So that the *idea* of *liberty* is the *idea* of a power in any agent to do or forbear any action, according to the determination or thought of the mind whereby either of them is preferred to the other. Where either of them is not in the power of the agent to be produced by him according to his volition, there he is not at liberty; that agent is under *neceſſity*. So that *liberty* cannot be where there is no *thought*, no *volition*, no *will;* but there may be thought, there may be will, there may be volition, where there is no *liberty*. Thus a *tennis-ball*, whether in motion by the ſtroke of a racket, or lying ſtill at reſt, is not by any one taken to be a free agent. So a man ſtriking himſelf or his friend by a convulſive motion of his arm, which it is not in his power by volition or the direction of his mind to ſtop or forbear; nobody thinks he has in this *liberty;* every one pities him, as acting by *neceſſity* and *conſtraint*. Again, ſuppoſe a man be carried while faſt aſleep into a room where is a perſon he longs to ſee, and be there locked faſt in beyond his power to get out; he awakes, and is glad to ſee himſelf in ſo deſirable company: which he ſtays willingly in, that is, prefers his ſtaying to going away. Is not this ſtay voluntary? no body will doubt it; and yet being locked faſt in, he is not at liberty to ſtay, he has not freedom to be gone. So that *liberty* is not an *idea* belonging to volition or preferring, but to the perſon having the power of doing, or forbearing to do, according as the mind ſhall chooſe or direct.

79. As it is in the motions of the body, ſo it is in the thoughts of our minds: where any one is ſuch, that we have power to take it up, or lay it by, according to the preference of the mind, there we are at liberty. A waking man is not at liberty to think, or not to think, no more than he is at liberty whether his body ſhall touch any other or no: but whether he will remove his contemplation from one *idea* to another, is many times in his choice. And then he is, in reſpect of his *ideas*, as much at liberty, as he is in reſpect of bodies he reſts on. He can at pleaſure remove himſelf from one to another: but yet ſome *ideas* to the mind, like ſome motions to the body, are ſuch, as in certain circumſtances it cannot avoid, nor obtain their abſence by the utmoſt effort it can uſe. Thus a man on the rack is not at liberty to lay by the *idea* of *pain*, and entertain other contemplations.

80. Wherever thought is wholly wanting, or the power to act or forbear according to the direction of thought, there neceſſity takes place. This, in an agent capable of volition, when the beginning or continuation of any action is contrary to the preference of his mind, is called *compulſion*; when the hindering or ſtopping any action is contrary to his volition, it is called *reſtraint:* agents that have no thought, no volition at all, are in every thing neceſſary agents.

Sect. XIX. *Of Mixed Modes.*

81. Mixed *modes* are combinations of *ſimple ideas* of different kinds. The mind being once furniſhed with ſimple *ideas*, can put them together in ſeveral compoſitions, without examining whether they exiſt ſo together in nature. And hence it is that theſe ideas are called *notions*, as if they had their original and conſtant exiſtence more in the thoughts of men than in the reality of things: and to form ſuch ideas, it ſufficed that the mind put the parts of them together, and that they were conſiſtent in the underſtanding, without conſidering whether they had any real being. There are three ways whereby we get theſe complex ideas of *mixed modes*.

Mixed Modes.

1ſt, By *experience*, and obſervation of things themſelves: Thus by ſeeing two men wreſtle, we get the *idea* of wreſtling.

2dly, By *invention*, or voluntary putting together of ſeveral ſimple *ideas* in our own minds: So he that firſt invented *printing*, had an *idea* of it firſt in his mind before it ever exiſted.

3dly, By *explaining* the names of actions we never ſaw, or nations we cannot ſee; and by enumerating all thoſe *ideas* which go to the making them up. Thus the mixed mode, which the word *lie* ſtands for, is made up of theſe ſimple *ideas:* 1ſt, *Articulate ſounds*. 2dly, *Certain* ideas *in the mind of the ſpeaker*. 3dly, *Thoſe words, the ſigns of theſe ideas*. 4thly, *Thoſe ſigns put together*, by affirmation or negation, otherwiſe than the *ideas* they ſtand for are in the mind of the ſpeaker. Since languages are made, *complex ideas* are uſually got by the explication of thoſe terms that ſtand for them: for ſince they conſiſt of ſimple *ideas* combined, they may, by words ſtanding for thoſe ſimple *ideas*, be repreſented to the mind of one who underſtands thoſe words, though that combination of ſimple *ideas* was never offered to his mind by the real exiſtence of things.

82. Mixed modes have their *unity* from an act of the mind, combining thoſe ſeveral ſimple *ideas* together, and conſidering them as one complex one: the mark of this union is one *name* given to that combination. Men ſeldom reckon any number of *ideas* to make one complex one: but ſuch collections as there be names for. Thus the *killing of an old man*, is as fit to be united into one *complex idea* as that of *a father:* yet there being no name for it, it is not taken for a particular complex *idea*, nor a diſtinct ſpecies of action from that of killing any other man.

83. Thoſe collections of *ideas* have names generally affixed which are of frequent uſe in converſation: in which caſes, men endeavour to communicate their thoughts to one another with all poſſible diſpatch. Thoſe others, which they have ſeldom occaſion to mention, they tie not together nor give them names.

84. This gives the reaſon why there are words in every language which cannot be rendered by any one ſingle word of another. For the faſhions and cuſtoms of one nation make ſeveral combinations of *ideas* familiar in one which another had never any occaſion to make. Such were *οστρακισμος* among the the Greeks, *proſcriptio* among the Romans. This alſo occaſions the *conſtant change* of languages; becauſe the change of cuſtom and opinions brings with it new combinations of *ideas*, which, to avoid long deſcriptions, have new names annexed to them, and ſo they become *new ſpecies* of *mixed* modes.

85. Of all our ſimple *ideas*, thoſe that have had moſt *mixed modes* made out of them, are, *thinking* and *motion*, which comprehend in them all action; and

power, from whence theſe actions are conceived to flow. For actions being the great buſineſs of mankind, it is no wonder if the ſeveral modes of thinking and motion ſhould be taken notice of, the *ideas* of them obſerved and laid up in memory, and have names aſſigned them. For without ſuch *complex ideas* with names to them, men could not eaſily hold any communication about them. Of this kind are the modes of actions diſtinguiſhed by their *cauſes*, *means*, *objects*, *ends*, *inſtruments*, *time*, *place*, and other circumſtances: as alſo of the powers fitted for thoſe actions. Thus *boldneſs* is the power to do or ſpeak what we intend, without fear or diſorder: which power of doing any thing, when it has been acquired by the frequent doing the ſame thing, is that *idea* we call *habit*; when forward, and ready upon every occaſion, to break into action, we call it *diſpoſition:* thus *teſtineſs* is a diſpoſition or aptneſs to be angry.

86. *Power* being the ſource of all action, the ſubſtances wherein theſe powers are, when they exert this power, are called *cauſes*; and the ſubſtances thereupon produced, or the ſimple *ideas* introduced into any ſubject, *effects*. The efficacy whereby the new ſubſtance or *idea* is produced, is called, in the ſubject exerting that power, *action*; in the ſubject, wherein any ſimple *idea* is changed or produced, *paſſion:* Which efficacy, in *intellectual agents*, we can conceive to be nothing elſe but modes of thinking and willing; in *corporeal agents*, nothing elſe but modifications of motion.

Sect. XX. *Of our Complex Ideas of Subſtances.*

87. The mind obſerving ſeveral ſimple *ideas* to go conſtantly together, which being preſumed to belong to one thing, are called, ſo united in one ſubject, by one name, which we are apt afterward to talk of and conſider as one ſimple *idea*, which indeed is a complication of many *ideas* together. We imagine not theſe ſimple *ideas* to ſubſiſt by themſelves: but ſuppoſe ſome *ſubſtratum* wherein they ſubſiſt, which we call *ſubſtance*. The *idea* of pure ſubſtance is nothing but the ſuppoſed (but unknown) ſupport of thoſe qualities which are capable of producing ſimple *ideas* in us.

88. The *ideas* of *particular circumſtances* are compoſed out of this obſcure and general *idea* of ſubſtance, together with ſuch combinations of ſimple *ideas* as are obſerved to exiſt together, and ſuppoſed to flow from the internal conſtitution and unknown eſſence of that ſubſtance. Thus we come by the *ideas* of *man*, *horſe*, *gold*, &c. Thus the ſenſible qualities of *iron*, or a *diamond*, make the complex *ideas* of thoſe ſubſtances which a ſmith or a jeweller commonly knows better than a philoſopher.

89. The ſame happens concerning the operations of the mind, viz. *thinking*, *reaſoning*, &c. which we concluding not to ſubſiſt by themſelves, nor apprehending how they can belong to body, or be produced by it, we think them the action of ſome other ſubſtance, which we call *ſpirit:* of whoſe ſubſtance or nature we have as clear a notion as of that of body; the one being but the ſuppoſed *ſubſtratum* of the ſimple *ideas* we have from without, as the other of thoſe operations which we experiment in ourſelves within: So that the *idea* of *corporeal ſubſtance* in matter, is as remote from our conceptions as that of *ſpiritual ſubſtance*.

90. Hence we may conclude, that he has the perfecteſt *idea* of any particular ſubſtance who has collected moſt of thoſe ſimple *ideas* which do exiſt in it; among which we are to reckon its *active powers* and *paſſive capacities*, though not ſtrictly *ſimple ideas*.

91. *Secondary qualities*, for the moſt part, ſerve to diſtinguiſh ſubſtance. For our ſenſes fail us in the diſcovery of the *bulk*, *figure*, *texture*, &c. of the minute parts of the bodies, on which their real conſtitutions and differences depend; and ſecondary are nothing but powers, with relation to our ſenſe. The *ideas* that make our complex ones of corporeal ſubſtances are of three ſorts: Firſt, The *ideas* of primary qualities of things, which are diſcovered by our ſenſes; ſuch are *bulk*, *figure*, *motion*, &c. Secondly, The ſenſible ſecondary qualities; which are nothing but powers to produce ſeveral *ideas* in us by our ſenſes. Thirdly, The aptneſs we conſider in any ſubſtance to cauſe or receive ſuch alterations of primary qualities, as that the ſubſtance ſo altered ſhould produce in us different *ideas* from what it did before; and they are called *active* and *paſſive powers*. All which, as we have any notice or notion of them, terminate in *ſimple ideas*.

92. Had we ſenſes acute enough to diſcern the minute particles of bodies, it is not to be doubted but they would produce quite different *ideas* in us; as we find in viewing things with *microſcopes*. Such bodies as to our naked eyes are coloured and opaque, will through *microſcopes* appear pellucid. *Blood* to the naked eye appears all red; but by a good *microſcope* we ſee only ſome red globules ſwimming in a tranſparent liquor.

93. Beſides theſe complex *ideas* we have of material ſubſtances; by the ſimple *ideas* taken from the operations of our own minds, which we experiment in ourſelves, as *thinking*, *underſtanding*, *willing*, *knowing*, &c. co-exiſting in the ſame ſubſtance, we are able to frame the complex *idea* of a *ſpirit*. And this *idea* of an *immaterial ſubſtance*, is as clear as that we have of a *material*. By joining theſe with ſubſtance, of which we have no diſtinct *idea*, we have the *idea* of a *ſpirit:* And by putting together the ideas of coherent ſolid parts, and power of being moved, joined with ſubſtance, of which likewiſe we have no poſitive *idea*, we have the *idea* of *matter*. The one is as clear and diſtinct as the other. The ſubſtance of *ſpirit* is unknown to us; and ſo is the ſubſtance of *body* equally unknown to us. Two primary qualities or properties of body, viz. *ſolid coherent parts*, and *impulſe*, we have diſtinct clear *ideas* of: So likewiſe have we of two primary qualities or properties of ſpirit, viz. *thinking*, and a *power of action*. We have alſo clear and diſtinct *ideas* of ſeveral qualities inherent in bodies, which are but the various modifications of the extenſion of cohering ſolid parts and their motion. We have likewiſe the *ideas* of the ſeveral modes of thinking, viz. Believing, doubting, hoping, fearing, &c. as alſo of willing and moving the body conſequent to it.

Sect. XXI. *Of Relation.*

94. There is another ſet of *ideas* which the mind gets

Of Cause and Effect. gets from the *comparing of one thing with another*. When the mind so considers one thing, that it does as it were bring it to and set it by another, and carry its view from one to the other, this is *relation* or *respect*; and the denominations given to things intimating that respect, are what we call *relatives*, and the things so brought together *related*. Thus when I call CAJUS, *husband*, or *whiter*, I intimate some other person, or thing, in both cases, with which I compare him. Any of our *ideas* may be the foundation of relation.

95. Where languages have failed to give correlative names, there the relation is not so easily taken notice of: As in *concubine*, which is a relative name as well as *wife*.

96. The *ideas* of relation may be the same in those men who have far different *ideas* of the things that are related. Thus those who have different *ideas* of *man*, may agree in that of *father*.

97. There is no *idea* of any kind which is not capable of an almost infinite number of considerations, in reference to other things; and therefore this makes no small part of mens words and thoughts. Thus one single man may at once sustain the relations of *father*, *brother*, *son*, *husband*, *friend*, *subject*, *general*, *European*, *Englishman*, *islander*, *master*, *servant*, *bigger*, *less*, &c. to an almost infinite number; he being capable of as many relations as there may be occasions of comparing him to other things in any manner of agreement, disagreement, or respect whatsoever.

SECT. XXII. *Of Cause and Effect, and other Relations.*

98. THE *ideas* of *cause* and *effect* we get from our observation of the *vicissitude of things*, while we perceive some qualities or substances begin to exist, and that they receive their existence from the due application and operation of other things: That which *produces*, is the *cause*; that which is *produced*, the *effect*. Thus *fluidity* in wax is the effect of a certain degree of heat, which we observe to be constantly produced by the application of such heat.

99. We distinguish the originals of things into two sorts.

100. First, When the thing is wholly made new, so that no part thereof did ever exist before, as when a new particle of matter doth begin to exist which had before no being, it is called *creation*.

101. Secondly, When a thing is made up of particles which did all of them before exist, but the thing so constituted of pre-existing particles, which all together make up such a collection of simple *ideas*, had not any existence before; as this *man*, this *egg*, this *rose*, &c.: this, when referred to a substance produced in the ordinary course of nature by an internal principle, but set on work by some external agent, and working by insensible ways which we perceive not, is called *generation*: When the cause is extrinsical, and the effect produced by a sensible separation, or juxtaposition of discernible parts, we call it *making*: and such are all artificial things. When any simple *idea* is produced, which was not in that subject before, we call it *alteration*.

102. The denomination of things taken from *time* are for the most part only relations. Thus when it is said that queen *Elizabeth* lived sixty-nine, and reigned forty-five years, no more is meant, than that the duration of her existence was equal to sixty-nine, and of her government to forty-five annual revolutions of the sun.

Identity and Diversity.

103. *Young* and *old*, and other words of time, that are thought to stand for positive ideas, are indeed relative; and intimate a relation to a certain length of duration, whereof we have the idea in our minds. Thus we call a man *young* or *old*, that has lived little or much of that time that men usually attain to. This is evident from our application of these names to other things; for a man is called *young* at twenty, but a horse *old*, &c. The sun and stars we call not *old* at all, because we know not what period God has set to that sort of beings.

104. There are other ideas that are truly *relative*, which we signify by names that are thought *positive* and *absolute*; such as *great* and *little*, *strong* and *weak*. The things thus denominated, are referred to some standards, with which we compare them. Thus we call an apple *great*, that is bigger than the ordinary sort of those we have been used to; and a man *weak*, that has not so much strength or power to move as men usually have.

SECT. XXIII. *Of Identity and Diversity.*

105. ANOTHER occasion the mind takes of comparing is, the very *being of things*. When considering a thing as existing at any certain time or place, and comparing it with itself as existing at any other time, &c. it forms the ideas of *identity* and *diversity*. When we see any thing in any certain time and place, we are sure it is that very thing, and can be no other, how like soever it may be in all other respects.

106. We conceiving it to be impossible that two things of the same kind should exist together in the same place, we conclude, that whatever exists any where at the same time, excludes all of the same kind, and is there itself alone. When therefore we demand whether any thing be the *same*, or no, it refers always to something that existed such a time, in such a place, which it was certain at that instant was the same with itself, and no other.

107. We have ideas of three sorts of substances: 1. Of *God*. 2. *Finite intelligences*. 3. *Bodies*.

First, God being eternal, unalterable, and everywhere, concerning his *identity* there can be no doubt.

Secondly, Finite spirits having had their determinate time and place of beginning to exist, the relation to that time and place will always determine to each its *identity* as long as it exists.

Thirdly, The same will hold of every particle of matter to which no addition or subtraction is made. These three exclude not one another out of the same place, yet each exclude those of the same kind out of the same place.

108. The identity and diversity of *modes* and *relations* are determined after the same manner that substances are; only the actions of finite beings, as *motion* and *thought*, consisting in succession, they cannot exist in different times and places as permanent beings: for no motion or thought, considered as at different times,

Identity and Diversity.

times, can be the ſame, each part thereof having a different beginning of exiſtence.

109. From whence it is plain, that exiſtence itſelf is the *principium individuationis*, which determinates a being to a particular time and place incommunicable to two beings of the ſame kind. Thus, ſuppoſe an *atom* exiſting in a determined time and place; it is evident that, conſidered in any inſtant, it is the ſame with itſelf, and will be ſo as long as its exiſtence continues. The ſame may be ſaid of two, or more, or any number of particles, whilſt they continue together. The maſs will be the ſame, however jumbled: but if one atom be taken away, it is not the ſame maſs.

110. In *vegetables*, the identity depends not on the ſame maſs, and is not applied to the ſame thing. The reaſon of this is, the difference between an animate body and maſs of matter; *this* being only the coheſion of particles any-how united: *the other*, ſuch a diſpoſition, an organization of parts, as is fit to receive and diſtribute nouriſhment, ſo as to continue and frame the wood, bark, leaves, &c. (of an *oak*, for inſtance) in which conſiſts the vegetable life. That therefore which has ſuch an organization of parts partaking of one common life, continues to be the ſame *plant*, though that life be communicated to new particles of matter, vitally united to the living plant. The caſe is not ſo much different in *brutes*, but that any one may hence ſee what makes an *animal*, and continues it the *ſame*.

111. The identity of the *ſame man* likewiſe conſiſts in a participation of the ſame continued life in ſucceeding particles of matter vitally united to the ſame organized body.

112. To underſtand *identity* aright, we muſt conſider what *idea* the word it is applied to ſtands for; it being one thing to be the *ſame ſubſtance*, another the *ſame man*, and a third the *ſame perſon*.

113. An *animal* is a living organized body; and the ſame animal is the ſame continued life communicated to different particles of matter, as they happen ſucceſſively to be united to that organized living body; and our notion of *man* is but of a particular ſort of animal.

114. *Perſon* ſtands for an intelligent being, that reaſons and reflects, and can conſider itſelf the ſame thing in different times and places; which it doth by that *conſciouſneſs* that is inſeparable from thinking. By this every one is to himſelf what he calls *ſelf*, without conſidering whether that *ſelf* be continued in the ſame or divers ſubſtances. In this conſiſts *perſonal identity*, or the ſameneſs of a rational being; and ſo far as this conſciouſneſs extends backward to any paſt action or thought, ſo far reaches the identity of that perſon. It is the ſame *ſelf* now it was then: and it is by the ſame *ſelf*, with this preſent one that now reflects on it, that that action was done.

115. *Self* is that conſcious thinking thing, whatever ſubſtance it matters not, which is conſcious of pleaſure or pain, capable of happineſs or miſery; and ſo is concerned for itſelf as far as that conſciouſneſs extends. That with which the conſciouſneſs of this preſent thinking thing can join itſelf, makes the ſame perſon, and is one ſelf with it; and ſo attributes to itſelf and owns all the actions of that thing as its own, as far as that conſciouſneſs reaches.

Various Relations.

116. This *perſonal identity* is the object of reward and puniſhment, being that by which every one is concerned for himſelf. If the *conſciouſneſs* went along with the little finger, when that was cut off, it would be the ſame ſelf that was juſt before concerned for the whole body.

117. If the ſame *Socrates*, waking and ſleeping, did not partake of the ſame conſciouſneſs, they would not be the ſame *perſon*. *Socrates* waking, could not be in juſtice accountable for what *Socrates* ſleeping did, no more than one *twin* for what his brother *twin* did becauſe their outſides were ſo like that they could not be diſtinguiſhed.

118. But ſuppoſe I wholly loſe the memory of ſome parts of life, beyond a poſſibility of retrieving them, ſo that I ſhall never be conſcious of them again: am I not the *ſame perſon* that did thoſe actions, though I have now forgot them? I anſwer, that we muſt here take notice what the word *I* is applied to, which in this caſe is the man only: and the ſame man being preſumed to be the ſame perſon, *I* is eaſily here ſuppoſed to ſtand alſo for the ſame perſon. But if it be poſſible for the ſame man to have diſtinct incommunicable conſciouſneſs at different times, it is paſt doubt the ſame man would, at different times, make different perſons. Which we ſee is the ſenſe of mankind in the ſolemneſt declaration of their opinions, human laws not puniſhing the mad man for the ſober man's actions, nor the ſober man for what the mad man did; thereby making them two perſons. Thus we ſay in *Engliſh*, ſuch a one *is not himſelf*, or is *beſides himſelf*; in which phraſe, it is inſinuated, that *ſelf* is changed, and the *ſelf-ſame perſon* is no longer in that man.

119. But is not a man drunk or ſober the ſame perſon? Why elſe is he puniſhed for the ſame fact he commits when drunk, tho' he be never afterwards conſcious of it? Juſt as much the ſame perſon as a man that walks and does other things in his ſleep is the ſame perſon, and is anſwerable for any miſchief he ſhall do in it. Human laws puniſh both with a juſtice ſuitable to their way of knowledge: becauſe in theſe caſes they cannot diſtinguiſh certainly what is real and what is counterfeit. And ſo the ignorance in drunkenneſs or ſleep, is not admitted as a plea: for tho' puniſhment be annexed to perſonality, and perſonality to conſciouſneſs; and the drunkard, perhaps, is not conſcious of what he did; yet human judicatures juſtly puniſh him, becauſe the fact is proved againſt him, but want of conſciouſneſs cannot be proved for him.

120. To conclude: whatever ſubſtance begins to exiſt, it muſt during its exiſtence be the ſame. Whatever compoſitions of ſubſtances begin to exiſt, during the union of thoſe ſubſtances, the concrete muſt be the ſame. Whatſoever mode begins to exiſt, during its exiſtence it is the ſame. And ſo if the compoſition be of diſtinct ſubſtances, and different modes, the ſame rule holds.

SECT. XXIV. *Of other Relations.*

121. ALL ſimple *ideas*, wherein are parts or degrees, afford an occaſion of comparing the ſubjects wherein they are to one another, in reſpect of thoſe ſimple *ideas*: As *whiter*, *ſweeter*, *more*, *leſs*, &c.

Various Relations.

These depending on the equality and excess of the same simple *ideas*, in several subjects, may be called *proportional relations*.

122. Another occasion of comparing things is taken from the circumstances of their origin; as *father*, *son*, *brother*, &c. These may be called *natural relations*.

123. Sometimes the foundation of considering things, is some act whereby any one comes by a moral right, power, or obligation to do something: Such are *general*, *captain*, *burgher*. These are *instituted* and *voluntary relations*; and may be distinguished from the *natural*, in that they are alterable and separable from the persons to whom they sometimes belonged, tho' neither of the substances so related be destroyed. But natural relations are not alterable, but are as lasting as their subjects.

124. Another relation is the conformity or disagreement of mens voluntary actions to a rule to which they are referred, and by which they are judged of: these may be called *moral relations*. It is this conformity or disagreement of our actions to some law (whereby good or evil is drawn on us from the will and power of the law-maker, and is what we call *reward* or *punishment*) that renders our actions morally good or evil.

125. Of these moral *rules* or *laws* there seem to be three sorts, with their different enforcements: first, The *divine law*; secondly, *Civil law*; thirdly, *The law of opinion* or *reputation*. By their relation to the first, our actions are either *sins* or *duties*; to the second, *criminal* or *innocent*; to the third, *virtues* or *vices*.

126. *First*, The *divine law* is that law which God has set to the actions of men, whether promulgated to them by the light of nature or the voice of revelation.

127. That God has given a law to mankind, seems undeniable, since he has, first, A right to do it; we are his creatures. Secondly, Goodness and wisdom, to direct our actions to what is best. Thirdly, Power to enforce it by reward and punishment, of infinite weight and duration. This is the only true touchstone of moral rectitude, and by which men judge of the most considerable moral good or evil of their actions; that is, whether, as duties or sins, they are like to procure to them happiness or misery from the hands of the Almighty.

128. *Secondly*, The *civil law* is the rule set by the commonwealth to the actions of those that belong to it. This law nobody overlooks; the rewards and punishments being ready at hand to enforce it, extending to the protecting or taking away of the life, liberty, and estate, of those who observe or disobey it.

129. *Thirdly*, The law of *opinion* or *reputation*. *Virtue* and *vice* are names supposed every where to stand for actions in their own nature right and wrong. As far as they are really so applied, they so far are coincident with the divine law. But it is visible that these names, in the particular instances of their application, through the several nations and societies of men, are constantly attributed only to such actions as in each country and society are in reputation or discredit. So that the measure of what is every where called and esteemed virtue and vice, is the approbation or dislike, praise or blame, which by a tacit consent establishes itself in the societies and tribes of men in the world; whereby several actions come to find credit or disgrace amongst them, according to the judgment, maxims, or fashions of the place.

130. That this is so, appears hence: That tho' that passes for virtue in one place which is elsewhere accounted vice, yet every where *virtue* and *praise*, *vice* and *blame*, go together. *Virtue* is every where that which is thought praise-worthy; and nothing else but that which has the allowance of public esteem, is called *virtue*. These have so close an alliance, that they are often called by the same name.

131. It is true, virtue and vice do, in a great measure, every where correspond with the unchangeable rule of right and wrong, which the laws of God have established; because the observation of these laws visibly secures and advances the general good of mankind, and the neglect of them breeds mischief and confusion: and therefore men, without renouncing all sense and reason, and their own interest, could not generally mistake in placing their commendation and blame on that side that deserved it not.

132. They who think commendation and disgrace not sufficient motives to engage men to accommodate themselves to the opinions and rules of those with whom they converse, seem little skilled in the history of mankind; the greatest part whereof govern themselves by this *law of fashion*.

133. The penalties that attend the breach of God's laws are seldom seriously reflected on; and those that do reflect on them entertain thoughts of future reconciliation; and for the punishment due from the laws of the commonwealth, men flatter themselves with the hopes of impunity: but no man escapes censure and dislike, who offends against fashion; nor is there one of ten thousand stiff and insensible enough to bear up under the constant dislike and condemnation of his own club.

134. *Morality* then is nothing but a relation to these laws or rules: and these rules being nothing else but a collection of several simple *ideas*, the conformity thereto is but so ordering the action that the simple *ideas* belonging to it may correspond to those which the law requires. By which we see, how moral beings and notions are founded on and terminated in the simple *ideas* of sensation and reflection. For example; let us consider the complex *idea* signified by the word *murder*. First, from reflection, we have the *ideas* of *willing*, *considering*, *purposing*, *malice*, &c. also of *life*, *perception*, and *self-motion*. Secondly, from sensation, we have the *ideas* of *man*, and of some action whereby we put an end to that perception and motion in the man: all which simple *ideas* are comprehended in the word *murder*.

135. This collection of simple *ideas* being found to agree or disagree with the esteem of the country I have been bred in, and to be held worthy of praise or blame, I call the action *virtuous* or *vicious*. If I have the will of a supreme invisible Law-maker for my rule; then as I suppose the action commanded or forbidden by *God*, I call it *good* or *evil*, *sin* or *duty*: if I compare it with the civil law of my country, I call it *lawful* or *unlawful*, a crime or no crime.

136. Moral actions may be considered two ways;

First,

Real and Fantastical Ideas.

First, As they are in themselves a collection of simple *ideas*; in which sense they are positive absolute *ideas*.

Secondly, As *good*, or *bad*, or *indifferent*: in this respect they are *relative*, it being their conformity or disagreement with some rule that makes them so. We ought carefully to distinguish between the positive *idea* of the action, and the reference it has to a rule; both which are commonly comprehended under one name, which often occasions confusion, and misleads the judgment.

137. Thus the taking from another what is his, without his consent, is properly called *stealing*: but that name being commonly understood to signify also the moral pravity of the action, men are apt to condemn whatever they hear called *stealing* as an ill action disagreeing with the rule of right. And yet the private taking away his sword from a madman, to prevent his doing mischief, though it be properly denominated *stealing*, as the name of such a mixed mode; yet, when compared to the law of God, it is no sin or transgression, tho' the name *stealing* ordinarily carries such an intimation with it.

Sect. XXV. *Of Real and Fantastical Ideas.*

138. Our *ideas*, in reference to things from whence they are taken, or which they may be supposed to represent, come under a *threefold* distinction; and are, first, either *real* or *fantastical*; secondly, *adequate* or *inadequate*; thirdly, *true* or *false*.

139. *Real ideas*, are such as have a foundation in nature, such as have a conformity with the real being and existence of things, or with their archetypes.

140. *Fantastical* are such as have no foundation in nature, nor any conformity with that reality of being to which they are referred as to their *archetypes*. By examining the several sorts of *ideas* we shall find, that, first, our *simple ideas* are all real; not that they are images or representations of what does exist, but as they are the certain effects of powers in things without us, ordained by our Maker to produce in us such sensations: they are real *ideas* in us, whereby we distinguish the qualities that are really in things themselves.

141. Their reality lies in the steady correspondence they have with the distinct constitutions of real beings. But whether they answer to those constitutions as to *causes* or *patterns*, it matters not; it suffices that they are constantly produced by them.

142. *Complex ideas*, being arbitrary combinations of *simple ideas* put together, and united under one general name, in forming of which the mind uses its liberty, we must inquire which of these are real, and which imaginary combinations.

143. First, Mixed modes and relations having no other reality than what they have in the minds of men, nothing else is required to make them real, but a possibility of existing conformable to them. These *ideas* being themselves *archetypes*, cannot differ from their *archetypes*, and so cannot be chimerical; unless any one will jumble together in them inconsistent *ideas*. Those indeed that have names assigned them in any language, must have a conformity to the ordinary signification of the name that is given them, that they may not be thought fantastical.

144. Secondly, Our complex *ideas* of substances being made, in reference to things existing without us, whose representations they are thought, are no farther real than as they are such combinations of *simple ideas* as are really united, and co-exist in things without us: those are fantastical which are made up of several *ideas* that never were found united, as *Centaur*, &c.

Of Ideas adequate or inadequate.

Sect. XXVI. *Of Ideas Adequate or Inadequate.*

145. Real *ideas* are either *adequate* or *inadequate*. First, *adequate*; which perfectly represents those archetypes which the mind supposes them taken from, and which it makes them to stand for. Secondly, *Inadequate*; which are such as do but partially or incompletely represent those archetypes to which they are referred. Whence it appears,

146. First, That all our *simple ideas* are *adequate*; for they being but the effects of certain powers in things fitted and ordained by God to produce such sensations in us, they cannot but be correspondent and adequate to such powers, and we are sure they agree to the reality of things.

147. Secondly, Our *complex ideas of modes* being voluntary collections of *simple ideas*, which the mind puts together without reference to any real archetypes, cannot but be *adequate ideas*. They are referred to no other pattern, nor made by any original, but the good-liking and will of him that makes the combination. If indeed one would conform his *ideas* to those which are formed by another person, they may be wrong or *inadequate*, because they agree not to that which the mind designs to be their archetype and pattern; in which respect only any *ideas* of modes can be wrong, imperfect, or inadequate.

148. Thirdly, Our *ideas of substances* have in the mind a double reference: First, They are sometimes referred to a supposed real essence, of each species of things; secondly, They are designed for representations in the mind, of things that do exist, by *ideas* discoverable in them: in both which respects they are *inadequate*.

149. First, If the names of substances stand for things, as supposed to have certain real essences, whereby they are of this or that species, of which real essences men are wholly ignorant; it follows, that the *ideas* they have in their minds, being referred to real essences as *archetypes* which are unknown, they must be so far from being adequate, that they cannot be supposed to be any representation of them at all. Our complex *ideas* of substances are nothing but certain collections of simple *ideas* that have been observed or supposed constantly to exist together. But such a complex *idea* cannot be the real essence of any substance: for then the properties we discover in it would be deducible from it, and their necessary connection with it be known; as all the properties of a *triangle* depend on and are deducible from the complex *idea* of *three lines including a space*: but it is certain, that in our complex *ideas* of substances are not contained such *ideas* on which all other qualities that are to be found in them depend.

150. Secondly, Those that take their *ideas* of substances from their sensible qualities, cannot form adequate *ideas* of them: because their qualities and powers

True and False Ideas.

powers are so various, that no man's complex *idea* can contain them all. Most of our simple *ideas*, whereof our complex ones of substances do consist, are powers, which being relations to other substances, we cannot be sure we know all the powers, till we have tried what changes they are fitted to give and receive from other substances in their several ways of application; which being not possible to be tried upon one body, much less upon all, it is impossible we should have adequate *ideas* of any substance made of a collection of all its properties.

Sect. XXVII. *Of True and False Ideas.*

151. Truth and *falsehood*, in propriety of speech, belong only to propositions; and when *ideas* are termed *true* or *false*, there is some secret or tacit proposition which is the foundation of that denomination. Our *ideas* being nothing but *appearances* or *perceptions* in the mind, can, in strictness of speech, no more be said to be true or false than single names of things can be said to be true or false. The *idea* of *Centaur* has no more falsehood in it when it appears in our minds, than the name *Centaur* when it is pronounced or writ on paper. For truth or falsehood lying always in some affirmation or negation, our *ideas* are not capable, any of them, of being false, till the mind passes some judgement on them, that is, affirms or denies something of them. In a *metaphysical* sense they may be said to be true, that is, to be really such as they exist; tho' in things called *true*, even in that sense, there is perhaps a secret reference to our *ideas*, looked upon as the standards of that truth; which amounts to a *mental proposition.*

152. When the mind refers any of its *ideas* to any thing extraneous to it, they are then capable of being true or false: because in such a reference, the mind makes a tacit supposition of their conformity to that thing; which supposition, as it is true or false, so the *ideas* themselves come to be denominated. This happens in these cases:

1st, When the mind supposes its *idea* conformable to that in other mens minds called by the same name, such as that of *justice*, *virtue*, &c.

2dly, When the mind supposes any *idea* conformable to some real existence. Thus, that of *Man* is true, that of *Centaur* false; the one having a conformity to what has really existed, the other not.

3dly, When the mind refers any of its *ideas* to that real constitution and essence of any thing whereon all its properties depend: and thus the greatest part, if not all our *ideas of substances* are false.

153. As to the first, when we judge of our *ideas* by their conformity to those of other men, they may be any of them false: but simple *ideas* are least liable to be so mistaken. We seldom mistake green for blue, or bitter for sweet; much less do we confound the names belonging to different senses, and call a *colour* by the name of a *taste*. Complex *ideas* are much more liable to falsehood in this particular; and those of mixed modes more than substances: because, in substances, their sensible qualities serve, for the most part, to distinguish them clearly; but in mixed modes we are more uncertain, and we may call that *justice* which ought to be called by another name. The reason of this is, that the abstract *ideas* of mixed modes being mens voluntary combination of such a precise collection of simple *ideas*, we have nothing else to refer our *ideas* of mixed modes or standards to, but the *ideas* of those who are thought to use names in their proper significations; and so as our *ideas* conform or differ from them, they pass for true or false.

154. As to the *second*, When we refer our *ideas* to the real existence of things, none can be termed *false* but our complex *ideas* of substances: for our simple *ideas* being nothing but perceptions in us answerable to certain powers in external objects, their truth consists in nothing but such appearances as are produced in us suitable to those powers: neither do they become liable to the imputation of falsehood, whether we judge these *ideas* to be in the things themselves, or no: for God having set them as marks of distinguishing things, that we may be able to discern one thing from another, and thereby choose them as we have occasion, it alters not the nature of our simple *ideas*, whether we think the *idea* of *blue* (for instance) to be in the violet itself, or in the mind only: and it is equally from that appearance to be denominated *blue*, whether it be that real colour, or only a peculiar texture in it, that causes in us that *idea*; since the name *blue* notes properly nothing but that mark of distinction that is in a violet, discernible only by our eyes, whatever it consists in.

155. Neither would our simple *ideas* be *false*, if by the different structure of our organs it were so ordered that the same object should produce in several mens minds different *ideas*: for this could never be known, since objects would operate constantly after the same manner. It is most probable, nevertheless, that the *ideas* produced by the same objects in different mens minds are very near and undiscernibly like. Names of simple *ideas* may be misapplied; as a man, ignorant in the *English* tongue, may call *purple*, *scarlet*: but this makes no falsehood in the *idea*.

156. Complex *ideas* of modes cannot be false, in reference to the essence of any thing really existing; because they have no reference to any pattern existing, or made by nature.

157. Our complex *ideas* of substances, being all referred to patterns in things themselves, may be false. They are so, *1st*, When looked upon as representations of the unknown essences of things: *2dly*, When they put together simple *ideas* which in the real existence of things have no union; as in *Centaur*. *3dly*, When from any collection of simple *ideas*, that do not always exist together, there is separated, by a direct negation, any one simple *idea* which is constantly joined with them. Thus, if from extension, solidity, fixedness, malleableness, fusibility, &c. we remove the colour observed in *gold*: if this *idea* be only left out of the complex one of *gold*, it is to be looked on as an inadequate and imperfect, rather than a false one; since though it contains not all the simple *ideas* that are united in nature, yet it puts none together but what do really exist together.

158. Upon the whole, our *ideas*, as they are considered by the mind, either in reference to the proper signification of their names, or in reference to the reality of things, may more properly be called *right* or *wrong ideas*, according as they agree or disagree to those patterns to which they are referred. The *ideas* that are in mens minds, simply considered, cannot be wrong

Association of Ideas.

wrong, unless *complex ideas*, wherein inconsistent parts are jumbled together. All other *ideas* are in themselves right, and the knowledge about them right and true knowledge. But when we come to refer them to any patterns, or archetypes, then they are capable of being wrong, as far as they disagree with such archetypes.

Sect. XXVIII. *Of the Association of Ideas.*

159. Some of our *ideas* have a natural correspondence and connection one with another: it is the office and excellency of our reason to trace these, and hold them together in that union and correspondence which is founded in their peculiar beings. Besides this, there is another connection of *ideas* wholly owing to chance or custom: *ideas* that in themselves are not at all of kin, come to be so united in some mens minds, that it is very hard to separate them; they always keep company, and the one no sooner comes into the understanding, but its associate appears with it; and if they are more than two, the whole gang always inseparably shew themselves together. This strong combination of *ideas*, not allied by nature, the mind makes in itself either voluntarily or by chance: and hence it comes in different men to be very different, according to their different *inclinations*, *educations*, *interests*, &c. Custom settles habits of thinking in the understanding, as well as of determining in the will, and of motions in the body; all which seem to be but trains of motion in the animal-spirits, which, once set a-going, continue on in the same steps they have been used to; which by often treading are worn into a smooth path, and the motion in it becomes easy, and, as it were, natural. As far as we can comprehend thinking, thus *ideas* seem to be produced in our minds; or if they are not, this may serve to explain their following one another in an habitual train, when once they are put into that tract, as well as it does to explain such motions of the body.

160. This connection in our minds of *ideas*, in themselves loose and independent one of another, is of so great force to set us awry in our actions, as well moral as natural, passions, reasonings, and notions themselves, that perhaps there is not any one thing that deserves more to be looked after. Thus the *ideas* of *goblins* and *sprights* have really no more to do with darkness than light; yet let but a foolish maid inculcate these often on the mind of a child, and raise them there together, possibly he shall never be able to separate them again so long as he lives, but darkness shall ever afterwards bring with it those frightful *ideas*. A man has suffered pain or sickness in any place; he saw his friend die in such a room; though these have in nature nothing to do one with another, yet when the *idea* of the *place* occurs to his mind, it brings that of the pain and displeasure with it; he confounds him in his mind, and can as little bear the one as the other.

161. *Intellectual habits* and defects this way contracted, are not less frequent and powerful, though less observed. Let the *ideas* of *being* and *matter* be strongly joined either by education or much thought, whilst these are still combined in the mind, what notions, what reasonings will there be about separate spirits? Let custom from the very childhood have joined figure and shape to the *idea* of God, and what absurdities will that mind be liable to about the Deity? Let the *idea* of *infalliblity* be joined to any person, and these two constantly together possess the mind; and then one body in two places at once shall be swallowed for a certain truth, whenever that imagined infallible person dictates, and demands assent without inquiry.

162. Some such wrong combinations of *ideas* will be found to establish the irreconcileable opposition between different sects of philosophy and religion: for we cannot imagine every one of their followers to impose wilfully on himself, and knowingly refuse truth offered by plain reason. Interest, though it does a great deal in the case, yet cannot be thought to work whole societies of men to so universal a perverseness, as that every one of them should knowingly maintain falsehood; some at least must be allowed to do what all pretend to, i. e. to pursue truth sincerely. That therefore which captivates their reasons, and leads men of sincerity blindfold from common sense, will, when examined, be found to be what we are speaking of: some independent *ideas* are by education, custom, and the constant din of their party, so coupled in their minds, that they always appear there together; and they can no more separate them in their thoughts, than if they were but one *idea*; and they operate as if they were so. This gives sense to jargon, demonstration to absurdities, and consistency to nonsense, and is the foundation of the greatest errors in the world. The confusion of two different *ideas*, which a customary connection of them in their minds hath to them in effect made but one, cannot but fill mens heads with false views, and their reasonings with false consequences.

Knowledge in general.

Sect. XXIX. *Of Knowledge in general.*

163. Since the mind, in all its thoughts and reasonings, has no other immediate object but its own *ideas*, which alone it does or can contemplate, it is evident that our knowledge is only conversant about them. *Knowledge* then seems to be nothing but the perception of the connection and agreement, or disagreement and repugnancy of any of our *ideas:* where this perception is, there is *knowledge;* and where it is not, there, though we fancy, guess, or believe, yet we always come short of *knowledge*. When we know that *white* is not *black*, what do we but perceive that these two *ideas* do not agree? Or that the three angles of a *triangle*, are equal to two right ones; what do we more but perceive that equality to two right ones does necessarily agree to and is inseparable from the three angles of a triangle? But to understand a little more distinctly wherein this agreement or disagreement consists, we may reduce it all to these *four sorts:* 1st, *Identity* or *diversity;* 2dly, *Relation;* 3dly, *Co-existence;* 4thly, *Real existence.*

164. I. *Identity* or *diversity*. It is the first act of the mind *to perceive its* ideas; and, so far as it perceives them, to know each what it is, and thereby to perceive their difference, that is, the one not to be the other: by this the mind clearly perceives each *idea* to agree with itself, and to be what it is; and all distinct *ideas* to disagree. This it does without any pains or deduction, by its natural power of perception and distinction. This is what men of art have reduced to those general rules, viz. *What is, is;* and, *It is impossible for the same thing to be and not to be.* But no

maxim

Knowledge. *maxim* can make a man know it clearer, that *round* is not *square*, than the bare perception of those two *ideas*, which the mind at first sight perceives to disagree.

165. II. The next sort of agreement or disagreement the mind perceives in any of its *ideas* may be called *relative*, and is nothing but the perception of the relation between any two *ideas* of what kind soever; that is, their agreement or disagreement one with another in several ways the mind takes of comparing them.

166. III. The third sort of agreement or disagreement to be found in our ideas, is, *coexistence* or *non-existence* in the same subject; and this belongs particularly to substances. Thus when we pronounce concerning *gold*, that it is fixed; it amounts to no more but this, that fixedness, or a power to remain in the fire unconsumed, is an *idea* that always accompanies that particular sort of *yellowness*, *weight*, *fusibility*, &c. which make our complex *idea* signified by the word *gold*.

167. IV. The fourth sort is that of actual and *real existence* agreeing to any *idea*. Within these four sorts of agreement or disagreement, is contained all the knowledge we have, or are capable of. For all that we know or can affirm concerning any *idea*, is, That it is, or is not, the same with some other; as, that *blue is not yellow:* That it does, or does not, coexist with another in the same subject; as, that *iron is susceptible of magnetical impressions:* That it has that or this relation to some other *ideas;* as, that *two triangles, upon equal bases upon two parallels, are equal:* or, That it has a real existence without the mind; as, *that God is*.

168. There are several ways wherein the mind is possessed of truth, each of which is called *knowledge*. *First*, There is *actual knowledge*, when the mind has a present view of the agreement or disagreement of any of its *ideas*, or of the relation they have one with another. *Secondly*, A man is said to know any proposition, when having once evidently perceived the agreement or disagreement of the *ideas* whereof it consists, and so lodged it in his memory, that whenever it comes to be reflected on again, the mind assents to it without doubt or hesitation, and is certain of the truth of it. And this may be called *habitual knowledge*. And thus a man may be said to know all those truths which are lodged in his memory by a foregoing, clear, and full perception.

169. Of *habitual knowledge* there are two sorts: the one is of such truths laid up in the memory, as whenever they occur to the mind, it actually perceives the relation that is between those *ideas*. And this is in all those truths, where the *ideas* themselves, by an immediate view, discover their agreement or disagreement one with another. The other is of such truths, whereof the mind having been convinced, it retains the memory of the conviction, without the proofs. Thus a man that remembers certainly, that he once perceived the demonstration, that the three angles of a triangle are equal to two right ones, knows it to be true, when that demonstration is gone out of his mind, and possibly cannot be recollected: but he knows it in a different way from what he did before, namely, not by the intervention of those intermediate *ideas*, whereby the agreement or disagreement of those in the proposition was at first perceived, but by remembering, i. e. knowing that he was once certain of the truth of this proposition, that the three angles of a triangle are equal to two right ones. The immutability of the same relations between the same immutable things, is now the *idea* that shews him, that if the three angles of a triangle were once equal to two right ones, they will always be so. And hence he comes to be certain, that what was once true, is always true; what *ideas* once agreed, will always agree; and consequently, what he once knew to be true, he will always know to be true, as long as he can remember that he once knew it. Degrees of Knowledge.

Sect. XXX. *Of the Degrees of our Knowledge.*

170. All our knowledge consisting in the view the mind has of its own *ideas*, which is the utmost light and greatest certainty we are capable of, *the different clearness of our knowledge* seems to lie in the different way of perception the mind has of the agreement or disagreement of any of its *ideas*.

171. When the mind perceives this agreement or disagreement of two *ideas immediately* by themselves, without the intervention of any other, we may call it *intuitive knowledge*; in which cases the mind perceives truth, as the eye does light, only by being directed towards it. Thus the mind perceives, that *white is not black;* that *three are more than two*, and *equal to one and two*. This part of knowledge is irresistible, and, like the bright sunshine, forces itself immediately to be perceived as soon as ever the mind turns its view that way. It is on this *intuition* that depends all the certainty and evidence of our other knowledge; which certainty every one finds to be so great, that he cannot imagine, and therefore not require a greater.

172. The next degree of knowledge is, where the mind perceives not this agreement or disagreement immediately, or by the *juxta-position*, as it were, of the *ideas*, because those *ideas* concerning whose agreement or disagreement the inquiry is made, cannot by the mind be so put together as to shew it. In this case the mind is fond to discover the agreement or disagreement which it searches, by the intervention of other *ideas:* And this is that which we call *reasoning*. And thus, if we would know the agreement or disagreement in bigness between the three angles of a triangle and two right angles, we cannot by an immediate view and comparing them do it; because the three angles of a triangle cannot be brought at once, and be compared with any other one or two angles. And so of this the mind has no immediate or intuitive knowledge. But we must find out some other angles to which the three angles of a triangle have equality; and finding those equal to two right ones, we come to know the equality of these three angles to two right ones. These intervening *ideas* which serve to shew the agreement of any two others, are called *proofs*; and where the agreement or disagreement is by this means plainly and clearly perceived, it is called *demonstration*. A quickness in the mind to find those proofs, and to apply them right, is that which is called *sagacity*.

173. This knowledge, though it be certain, is not so clear and evident as *intuitive* knowledge. It requires pains and attention, and steady application of mind, to discover the agreement or disagreement of the *ideas* it considers; and there must be a progression by steps and degrees before the mind can in this way

Degrees of Knowledge.

arrive at certainty. Before demonſtration there was a doubt, which, in *intuitive knowledge*, cannot happen to the mind that has its faculty of perception left to a degree capable of diſtinct *ideas*, no more than it can be a doubt to the eye (that can diſtinctly ſee *white* and *black*) whether this ink and paper be all of a colour.

174. Now, in every ſtep that reaſon makes in *demonſtrative knowledge*, there is an *intuitive knowledge* of that agreement or diſagreement it ſeeks with the next immediate *idea*; which it uſes as a proof: for if it were not ſo, that yet would need a proof; ſince without the perception of ſuch agreement or diſagreement, there is no knowledge produced. By which it is evident, that every ſtep in reaſoning that produces knowledge has *intuitive certainty*; but when the mind perceives, there is no more required but to remember it, to make the agreement or diſagreement of the *ideas* concerning which we inquire viſible and certain. This *intuitive perception* of the agreement or diſagreement of the intermediate *ideas* in each ſtep and progreſſion of the demonſtration, muſt alſo be exactly carried in the mind; and a man muſt be ſure that no part is left out; which becauſe in long deductions the memory cannot eaſily retain, this knowledge becomes more imperfect than *intuitive*, and men often embrace falſehoods for demonſtrations.

175. It has been generally taken for granted, that mathematics alone are capable of demonſtrative certainty. But to have ſuch an agreement or diſagreement as may be *intuitively* perceived, being not the privilege of the ideas of *number*, *extenſion*, and *figure* alone, it may poſſibly be the want of due method and application in us, and not of ſufficient evidence in things, that demonſtration has been thought to have ſo little to do in other parts of knowledge: For in whatever ideas the mind can perceive the agreement or diſagreement immediately, there it is capable of *intuitive knowledge*: And where it can perceive the agreement or diſagreement of any two *ideas* by an *intuitive perception* of the agreement or diſagreement they have with any intermediate *ideas*, there the mind is capable of demonſtration which is not limited to the ideas of figure, number, extenſion, or their modes. The reaſon why it has been generally ſuppoſed to belong to them only, is becauſe in comparing their equality or exceſs the *modes of numbers* have every the leaſt difference very clear and perceivable: And in *extenſion*, though every the leaſt exceſs is not ſo perceptible, yet the mind has found out ways to diſcover the juſt equality of two angles, extenſions, or figures; and both, that is, numbers and figures, can be ſet down by viſible and laſting marks.

176. But in other ſimple *ideas*, whoſe modes and differences are made and counted by degrees, and not quantity, we have not ſo nice and accurate a diſtinction of their differences as to perceive or find ways to meaſure their juſt equality or the leaſt differences: for thoſe other ſimple ideas being appearances or ſenſations produced in us by the *ſize*, *figure*, *motion*, &c. of minute corpuſcles ſingly inſenſible, their different degrees alſo depend on the variation of ſome or all of thoſe cauſes; which ſince it cannot be obſerved by us in particles of matter, whereof each is too ſubtile to be perceived, it is impoſſible for us to have any exact meaſures of the different degrees of theſe ſimple *ideas*. Thus, for inſtance, not knowing what number of particles, nor what motion of them, is fit to produce any preciſe degree of *whiteneſs*, we cannot demonſtrate the certain equality of any two degrees of *whiteneſs*, becauſe we have no certain ſtandard to meaſure them by, nor means to diſtinguiſh every the leaſt difference; the only help we have being from our ſenſes, which in this point fail us.

Extent of Knowledge.

177. But where the difference is ſo great as to produce in the mind *ideas* clearly diſtinct, there *ideas* of *colours*, as we ſee in different kinds, (*blue* and *red*, for inſtance), are as capable of demonſtration as ideas of number and extenſion. What is here ſaid of colours holds true in all ſecondary qualities. Theſe two then, *intuition* and *demonſtration*, are the degrees of our *knowledge*; whatever comes ſhort of one of theſe is but *faith* or *opinion*, not *knowledge*, at leaſt in all *general truths*. There is indeed another perception of the mind employed about the *particular exiſtence of finite beings* without us; which going beyond probability, but not reaching to either of the foregoing degrees of certainty, paſſes under the name of *knowledge*.

178. Nothing can be more certain than that the *idea* we receive from an external object is in our minds: This is *intuitive knowledge*; but whether we can thence certainly infer the exiſtence of any thing without us correſponding to that idea, is that whereof ſome men think there may be a queſtion made, becauſe men may have ſuch an idea in their minds when no ſuch things exiſt, no ſuch object affects their ſenſes. But it is evident that we are invincibly conſcious to ourſelves of a different perception, when we look upon the ſun in the day, and think on it by night; when we actually taſte wormwood or ſmell a roſe, or only think on that ſavour or odour. So that we may add to the two former ſorts of knowledge this alſo of the exiſtence of particular external objects, by that perception and conſciouſneſs we have of the actual entrance of ideas from them, and allow theſe three degrees of knowledge, viz. *intuitive*, *demonſtrative*, and *ſenſitive*.

179. But ſince our knowledge is founded on and employed about our ideas only, will it follow thence that it muſt be conformable to our ideas; and that where our ideas are clear and diſtinct, obſcure and confuſed, there our knowledge will be ſo too? *No*. For our knowledge conſiſting in the perception of the agreement or diſagreement of any two ideas, its clearneſs or obſcurity conſiſts in the clearneſs or obſcurity of that perception, and not in the clearneſs or obſcurity of the ideas themſelves. A man (for inſtance) that has a clear idea of the angles of a triangle, and of equality to two right ones, may yet have but an obſcure perception of their agreement; and ſo have but a very obſcure knowledge of it. But obſcure and confuſed ideas can never produce any clear or diſtinct knowledge; becauſe, as far as any ideas are obſcure or confuſed, ſo far the mind can never perceive clearly whether they agree or diſagree.

Sect. XXXI. *Of the Extent of Human Knowledge.*

180. From what has been ſaid concerning knowledge, it follows, Firſt, That we can have no knowledge

Extent of Knowledge

ledge farther than we have *ideas*.

Secondly, That we have no knowledge farther than we can have perception of that agreement or disagreement of our *ideas*, either by *intuition*, *demonstration*, or *sensation*.

Thirdly, We cannot have an *intuitive* knowledge that shall extend itself to all our *ideas*, and all that we would know about them, because we cannot examine and perceive all the relations they have one to another by juxta-position, or an immediate comparison one with another. Thus we cannot *intuitively* perceive the equality of two extensions, the difference of whose figures makes their parts incapable of an exact immediate application.

Fourthly, Our *rational* knowledge cannot reach to the whole extent of our *ideas*; because between two different *ideas* we would examine, we cannot always find such *proofs* as we can connect one to another, with an *intuitive knowledge* in all the parts of the deduction.

Fifthly, *Sensitive* knowledge reaching no farther than the existence of things actually present to our senses, is yet much narrower than either of the former.

Sixthly, From all which it is evident, that the *extent of our knowledge* comes not only short of the reality of *things*, but even of the extent of our own *ideas*. We have the *ideas* of a *square*, a *circle*, and *equality*; and yet perhaps shall never be able to find a *circle equal to a square*.

181. The affirmations or negations we make concerning the ideas we have, being reduced to the four sorts above-mentioned, viz. *identity*, *coexistence*, *relation*, and *real existence*, we shall examine how far our knowledge extends in each of these.

182. First, As to *identity* and *diversity*, our *intuitive knowledge* is as far extended as our *ideas* themselves; and there can be no *idea* in the mind which it does not presently, by an *intuitive knowledge*, perceive to be what it is, and to be different from any other.

183. Secondly, As to the agreement or disagreement of our *ideas* in *coexistence*: in this our knowledge is very short; tho' in this consists the greatest and most material part of our knowledge, concerning *substances*. For our *ideas* of *substances* being nothing but certain *collections of simple* ideas, *coexisting in one subject*, (our *idea* of *flame*, for instance, is a body *hot*, *luminous*, and *moving upward*; when we would know any thing farther concerning this, or any other sort of substance, what do we do but inquire what other qualities or powers these substances have, or have not? Which is nothing else but to know what other simple *ideas* do or do not *coexist* with those that make up that complex *idea*. The reason of this is, because the simple *ideas* which make up our complex *ideas* of substances, have no visible necessary connection or inconsistence with other simple *ideas* whose coexistence with them we would inform ourselves about. These *ideas* being likewise, for the most part, *secondary qualities*, which depend upon the *primary* qualities of their minute or insensible parts, or on something yet more remote from our comprehension, it is impossible we should know which have a necessary union or inconsistency one with another, since we know not the root from whence they spring, or the size, figure, and texture of parts on which they depend, and from which they result.

184. Besides this, there is no *discoverable connection* between any *secondary* quality, and those *primary* qualities that it depends on. We are so far from knowing what figure, size, or motion produces (for instance), a *yellow colour*, or *sweet taste*, or a *sharp sound*, that we can by no means conceive how any *size*, *figure*, or *motion*, can possibly produce in us the *idea* of any *colour*, *taste*, or *sound*, whatsoever; and there is no conceivable connection between the one and the other.

185. Our knowledge therefore of coexistence reaches little farther than *experience*. Some few, indeed, of the *primary* qualities have a necessary dependence and visible connection one with another; as *figure* necessarily supposes *extension*, *receiving or communicating motion by impulse* supposes *solidity*. But qualities coexistent in any subject, without this dependence and connection, cannot certainly be known to coexist any farther than experience by our senses informs us. Thus, though upon trial we find *gold* yellow, weighty, malleable, fusible, and fixed, yet because none of these have any evident dependence or necessary connection with the other, we cannot certainly know that where any *four* of these are, the *fifth* will be there also, how highly probable soever it may be: but the highest degree of *probability* amounts not to *certainty*; without which there can be no true knowledge: for this coexistence can be no further known, than it is perceived; and it cannot be perceived, but either, in *particular* subjects, by the observation of our senses, or, in *general*, by the necessary connection of the *ideas* themselves.

186. As to *incompatibility*, or *repugnancy to coexistence*, we may know, that any subject can have of each sort of *primary* qualities but one particular at once, one extension, one figure; and so of sensible *ideas*, peculiar to each sense: for whatever of each kind is present in any subject, excludes all others of that sort; for instance, one subject cannot have *two smells* or *two colours* at the same time.

187. As to *powers of substances*, which make a great part of our inquiries about them, and are no inconsiderable branch of our knowledge; our knowledge as to these reaches little farther than *experience*, because they consist in a texture and motion of parts which we cannot by any means come to discover. *Experience* is that which in this part we must depend on; and it were to be wished that it were more improved.

188. As to the third sort, the *agreement or disagreement of our ideas in any other relation*, this is the largest field of knowledge, and it is hard to determine how far it may extend. This part depending on our sagacity in finding intermediate *ideas* that may shew the habitudes and relations of *ideas*, it is an hard matter to tell when we are at the end of such discoveries. They that are ignorant of *algebra*, cannot imagine the wonders in this kind that are to be done by it; and what further improvements and helps advantageous to other parts of knowledge the sagacious mind of man may yet find out, it is not easy to determine. The *ideas* of *quantity* are not those alone that are capable of demonstration and knowledge; other, and perhaps more useful parts of contemplation, would un-

Extent of Knowledge. doubtedly afford us certainty, if vices, passions, and domineering interest, did not oppose or menace endeavours of this kind.

189. The *idea* of a *Supreme Being*, infinite in power, goodness, and wisdom, whose workmanship we are, and on whom we depend; and *ideas* of *ourselves*, as understanding rational creatures; would, if duly considered, afford such foundation of our *duty*, and *rules of action*, as might place *morality* among the sciences capable of demonstration. The relations of other modes may certainly be perceived, as well as those of number and extension. *Where there is no property, there is no injustice*, is a proposition as certain as any demonstration in Euclid: for the *idea* of *property* being a right to any thing; and the *idea* of *injustice* being the invasion or violation of that right; it is evident, that these *ideas* being thus established, and these names annexed to them, we can as certainly know this proposition to be true, as that a *triangle has three angles equal to two right ones*. Again, *No government allows absolute liberty*. The *idea* of *government* being the establishment of society upon certain rules or laws which require conformity to them, and the *idea* of *absolute liberty* being for any one to do whatever he pleases, we are as capable of being certain of the truth of this proposition as of any in *mathematics*.

190. What has given the advantage to the *ideas* of *quality*, and made them thought more capable of certainty and demonstration, is,

191. First, That they can be represented by sensible marks, which have a nearer correspondence with them than any words or sounds. *Diagrams* drawn on paper are copies of the *ideas*, and not liable to the uncertainty that words carry in their signification: but we have no sensible marks that resemble our *moral ideas*, and nothing but words to express them by; which though when written they remain the same, yet the *ideas* they stand for may change in the same man; and it is very seldom that they are not different in different persons.

192. Secondly, *Moral ideas* are commonly more complex than figures. Whence these two inconveniences follow: 1. That their names are of more uncertain signification; the precise collection of simple *ideas* they stand for not being so easily agreed on, and so the sign that is used for them, in communication always, and in thinking often, does not steadily carry with it the same *idea*. 2. The mind cannot easily retain those precise combinations so exactly and perfectly as is necessary, in the examination of the habitudes and correspondencies, agreements or disagreements, of several of them one with another, especially where it is to be judged of by long deductions, and the intervention of several other complex *ideas* to shew the agreement or disagreement of two remote ones.

193. Now one part of these disadvantages in *moral ideas*, which has made them to be thought not capable of demonstration, may in a good measure be remedied by *definitions*, setting down that collection of simple *ideas* which every term shall stand for, and then using the terms steadily and constantly for that precise collection.

194. As to the fourth sort of knowledge, viz. of *the real actual existence of things*, we have an *intuitive* knowledge of our *own existence*; a *demonstrative* knowledge of *the existence of God*; and a *sensitive* knowledge of the *objects that present themselves to our sense*.

Causes of Ignorance.

195. From what has been said, we may discover the *causes of our ignorance*, which are chiefly these three: First, Want of *ideas*: Secondly, Want of a discoverable connection between the *ideas* we have: Thirdly, Want of tracing and examining our *ideas*.

196. First, There are some things we are ignorant of for *want of ideas*. All the simple *ideas* we have are confined to the observations of our senses, and the operations of our own minds that we are conscious of in ourselves. What other *ideas* it is possible other creatures may have by the assistance of other senses and faculties more or perfecter than we have, or different from ours, it is not for us to determine; but to say or think there are no such, because we conceive nothing of them, is no better an argument, than if a blind man should be positive in it, that there was no such thing as sight and colours, because he had no manner of *idea* of any such thing. What faculties therefore other species of creatures have to penetrate into the nature and inmost constitutions of things, we know not. This we know, and certainly find, that we want other views of them, besides those we have, to make discoveries of them more perfect. The *intellectual* and *sensible* world are in this perfectly alike, that the parts which we see of either of them hold no proportion with that we see not, and whatsoever we can reach with our eyes or our thoughts of either of them is but a point almost nothing in comparison of the rest.

197. Another great cause of ignorance, is the *want of ideas that we are capable of*. This keeps us in ignorance of things we conceive capable of being known. Bulk, figure, and motion, we have *ideas* of; yet not knowing what is the particular bulk, motion, and figure, of the greatest part of the bodies of the universe, we are ignorant of the several powers, efficacies, and ways of operation, whereby the effects we daily see are produced. These are hid from us, in some things, by being *too remote*; in others, by being *too minute*.

198. When we consider the vast distance of the known and visible parts of the world, and the reasons we have to think that what lies within our ken is but a small part of the immense universe, we shall then discover an huge abyss of ignorance. What are the particular fabrics of the great masses of matter which make up the whole stupendous frame of corporeal beings; how far they are extended; what is their motion, and how continued; and what influence they have upon one another; are contemplations, that at first glimpse our thoughts lose themselves in. If we confine our thoughts to this little system of our sun, and the grosser masses of matter that visibly move about it; what several sorts of vegetables, animals, and intellectual corporeal beings, infinitely different from those of our little spot of earth, may probably be in other *planets*, to the knowledge of which, even of their outward figures and parts, we can no way attain whilst we are confined to this earth, there being no natural means, either by sensation or reflection, to convey their certain *ideas* into our minds?

199. There are other bodies in the universe, no less con-

Causes of Ignorance.

concealed from us by their *minuteneſs*. Theſe inſenſible corpuſcles being the active parts of matter, and the great inſtruments of nature on which depend all their *ſecondary* qualities and operations, our want of precise diſtinct *ideas* of their *primary* qualities keeps us in incurable ignorance of what we deſire to know about them. Did we know the mechanical affections of *rhubarb* and *opium*, we might as eaſily account for their operations of *purging* or *cauſing ſleep*, as a watchmaker can for the motions of his watch. The diſſolving of ſilver in *aqua fortis*, or gold in *aqua regia*, and not *vice verſa*, would be then, perhaps, no more difficult to know, than it is to a ſmith to underſtand why the turning of one key will open a lock, and not the turning of another. But whilſt we are deſtitute of ſenſes acute enough to diſcover the minute particles of bodies, and to give us *ideas* of their mechanical affections, we muſt be content to be ignorant of their properties and operations : nor can we be aſſured about them any farther than ſome few trials we make are able to reach ; but whether they will ſucceed again another time, we cannot be certain. This hinders our certain knowledge of univerſal truths concerning natural bodies; and our reaſon carries us herein very little beyond particular matters of fact. And therefore, how far ſoever human induſtry may advance uſeful and *experimental philoſophy* in phyſical things, yet *ſcientifical* will ſtill be out of our reach ; becauſe we want perfect and adequate *ideas* of thoſe very bodies which are neareſt to us, and moſt under our command.

200. This, at firſt ſight, ſhews us how diſproportionate our knowledge is to the whole extent, even of *material* beings ; to which if we add the conſideration of that infinite number of *ſpirits* that may be, and probably are, which are yet more remote from our knowledge, whereof we have no cognizance ; we ſhall find this cauſe of ignorance conceal from us, in an impenetrable obſcurity, almoſt the whole *intellectual* world, a greater, certainly, and a more beautiful world than the *material :* for bating ſome very few *ideas* of ſpirit we get from our own mind by reflection, and from thence the beſt we can collect of the *Father of all ſpirits*, the Author of them and us and all things, we have no certain information ſo much as of the exiſtence of other ſpirits but by revelation ; much leſs have we diſtinct *ideas* of their different natures, ſtates, powers, and ſeveral conſtitutions, wherein they agree or differ one from another, and from us ; and therefore in what concerns their different ſpecies and properties, we are under an abſolute ignorance.

201. The *ſecond* cauſe of ignorance, is the *want of diſcoverable connection* between thoſe *ideas* we have : where we want that, we are utterly incapable of *univerſal* and *certain* knowledge : and are, in the former caſe, left only to *obſervation* and *experiment*. Thus the mechanical affections of bodies having no affinity at all with the *ideas* they produce in us, we can have no diſtinct knowledge of ſuch operations beyond our experience ; and can reaſon no otherwiſe about them, than as the effects or appointment of an infinitely *wiſe agent*, which perfectly ſurpaſs our comprehenſions.

202. The operation of our minds upon our bodies is as inconceivable. How any *thought* ſhould produce a motion in *body*, is as remote from the nature of our *ideas*, as how any *body* ſhould produce any *thought* in the *mind*. That it is ſo, if experience did not convince us, the conſideration of the things themſelves would never be able in the leaſt to diſcover to us.

Reality of Knowledge.

203. In ſome of our *ideas* there are certain relations, habitudes, and connections, ſo viſibly included in the nature of the *ideas* of themſelves, that we cannot conceive them ſeparable from them by any power whatſoever : in theſe only we are capable of certain and univerſal knowledge. Thus the *idea* of a *right-lined triangle*, neceſſarily carries with it an *equality of its angles to two right ones*. But the coherence and continuity of the parts of matter, the production of ſenſation in us of *colours* and *ſounds*, &c. by impulſe and motion, being ſuch wherein we can diſcover no natural connection with any *ideas* we have, we cannot but aſcribe them to the arbitrary will and good pleaſure of the wiſe Architect.

204. The things that we obſerve conſtantly to proceed regularly, we may conclude to act by a law ſet them ; but yet by a law that we know not ; whereby, tho' cauſes work ſteadily, and effects conſtantly flow from them, yet their connections and dependencies being not diſcoverable in our *ideas*, we can have but an experimental knowledge of them.

205. The *third* cauſe of ignorance, is our *want of tracing thoſe ideas we have* or may have, and finding out thoſe intermediate *ideas* which may ſhew us what habitude of agreement or diſagreement they may have one with another : and thus many are ignorant of *mathematical* truths, for want of application in inquiring, examining, and by due ways comparing thoſe *ideas*.

206. Hitherto we have examined the *extent* of our knowledge in reſpect of the ſeveral ſorts of beings that are : there is another *extent* of it, in reſpect of *univerſality*, which will alſo deſerve to be conſidered ; and in this regard our knowledge follows the nature of our *ideas*. If the *ideas* are *abſtract*, whoſe agreement or diſagreement we perceive, our knowledge is *univerſal*. For what is known of ſuch general *ideas*, will be true of every particular thing in which that *eſſence*, that is, *abſtract idea*, is to be found : and what is once known of ſuch *ideas*, will be perpetually and for ever true. So that, as to all general knowledge, we muſt ſearch and find it only in our own minds : and it is only the examining of our own *ideas* that furniſhes us with that. Truths belonging to eſſences of things, (that is, to *abſtract ideas*), are *eternal*, and are to be found out by the contemplation only of thoſe eſſences, as the exiſtence of things is to be known only from experience.

Sect. XXXII. *Of the Reality of our Knowledge.*

207. The reader by this time may be ready to object, If it be true, that all knowledge lies only in the perception of the agreement or diſagreement of our own *ideas*, the viſions of an *enthuſiaſt*, and the reaſonings of a *ſober* man, will be equally certain : it is no matter how things are, ſo a man obſerve but the agreement of his own imaginations, and talk conformably ; it is all truth, all certainty.

208. To this it is anſwered, That if our knowledge of our *ideas* ſhould terminate in them, and reach no farther,

Reality of Knowledge. farther, when there is ſomething farther intended, our moſt ſerious thoughts would be of little more uſe than the *reveries* of a crazy brain. But it is evident, that this way of *certainty*, by the knowledge of our own *ideas*, goes a little farther than bare imagination; and that all the certainty of general truths a man has, lies in nothing elſe but this knowledge of our *ideas*.

209. It is evident, that the mind knows not things immediately, but by the intervention of the *ideas* it has of them. Our knowledge therefore is *real*, only ſo far as there is a conformity between our *ideas* and the reality of things. But how ſhall we know when our *ideas* agree with things themſelves? There are *two ſorts* of *ideas*, that we may be aſſured agree with things: theſe are,

210. Firſt, *Simple* ideas; which ſince the mind can by no means make to itſelf, muſt be the effect of things operating upon the mind in a natural way, and producing therein thoſe perceptions, which, by the will of our Maker, they are ordained and adapted to. Hence it follows, that *ſimple ideas* are not fictions of our fancies, but the natural and regular productions of things without us, really operating upon us; which carry with them all the conformity our ſtate requires, which is to repreſent things under thoſe appearances they are fitted to produce in us. Thus the *idea* of *whiteneſs*, as it is in the mind, exactly anſwers that power which is in any body to produce it there. And this conformity between our *ſimple ideas*, and the exiſtence of things, is ſufficient for real knowledge.

211. Secondly, All our *complex ideas*, except thoſe of ſubſtances, being *archetypes* of the mind's own making, and not referred to the exiſtence of things as to their originals, cannot want any conformity neceſſary to real knowledge: for that which is not deſigned to repreſent any thing but itſelf, can never be capable of a wrong repreſentation. Here the *ideas* themſelves are conſidered as *archetypes*, and things no otherwiſe regarded than as they are conformable to them. Thus the mathematician conſiders the truth and properties belonging to a *rectangle* or *circle* only as they are *ideas* in his own mind, which poſſibly he never found exiſting mathematically, that is, preciſely true: yet his knowledge is not only certain, but *real*; becauſe real things are no farther concerned, nor intended to be meant by any ſuch propoſitions, than as things really agree to thoſe *archetypes* in his mind. It is true of the *idea* of a *triangle*, *that its three angles are equal to two right ones*: it is true alſo of a *triangle*, wherever it *exiſts*: what is true of thoſe *figures* that have barely an *ideal* exiſtence in his mind, will hold true of them alſo when they come to have a *real* exiſtence in matter.

212. Hence it follows, that *moral* knowledge is as capable of *real certainty* as *mathematics*: For *certainty* being nothing but the perception of the agreement or diſagreement of our *ideas*, and demonſtration nothing but the perception of ſuch agreement by the intervention of other *ideas*; our *moral ideas*, as well as *mathematical*, being *archetypes* themſelves, and ſo adequate or complete *ideas*, all the agreement or diſagreement we ſhall find in them will produce *real* knowledge, as well as in *mathematical figures*. That which is requiſite to make our knowledge *certain*, is the clearneſs of our *ideas*; and that which is required to make it *real*, is, that they anſwer their *archetypes*.

213. Thirdly, But the complex *ideas*, which we refer to *archetypes* without us, may differ from them, and ſo our knowledge about them may come ſhort of being real; and ſuch are our *ideas* of *ſubſtances*. Theſe muſt be taken from ſomething that does or has exiſted, and not be made up *ideas* arbitrarily put together without any real pattern. Herein, therefore, is founded the reality of our knowledge concerning *ſubſtances*, that all our complex *ideas* of them muſt be ſuch, and ſuch only, as are made up of ſuch ſimple ones as have been diſcovered to coexiſt in nature. And our *ideas* being thus true, though not perhaps very exact copies, are the ſubjects of the *real* knowledge of them. Whatever *ideas* we have, the agreement we find they have with others will be knowledge. If thoſe *ideas* be abſtract, it will be *general* knowledge. But to make it *real* concerning *ſubſtances*, the *ideas* muſt be taken from the real exiſtence of things. Wherever, therefore, we perceive the agreement or diſagreement of our *ideas*, there is *certain knowledge*: and wherever we are ſure thoſe *ideas* agree with the reality of things, there is *certain real knowledge*.

Sect. XXXIII. *Of Truth in general.*

Of truth.

214. Truth, in the proper import of the word, ſignifies the joining or ſeparating of ſigns, as the things ſignified by them do agree or diſagree one with another. The joining or ſeparating of ſigns, is what we call *propoſitions*; ſo that *truth* properly belongs only to *propoſitions*: whereof there are two ſorts, *mental* and *verbal*; as there are *two* ſorts of ſigns commonly made uſe of, *ideas* and *words*.

215. It is difficult to treat of *mental* propoſitions without *verbal*; becauſe, in ſpeaking of *mental*, we muſt make uſe of *words*, and then they become *verbal*. Again, men commonly in their thoughts and reaſonings uſe *words* inſtead of *ideas*; eſpecially if the ſubject of their meditation contains in it *complex ideas*. If we have occaſion to form *mental* propoſitions about *white*, *black*, *circle*, &c. we can, and often do, frame in our minds the *ideas* themſelves, without reflecting on the *names*: but when we would conſider, or make propoſitions about the more *complex ideas*, as of a *man*, *vitriol*, *fortitude*, *glory*, &c. we uſually put the *name* for the *idea*; becauſe the *idea* theſe *names* ſtand for being for the moſt part confuſed, imperfect, and undetermined, we reflect on the *names* themſelves, as being more clear, certain, and diſtinct, and readier to occur to our thoughts, than pure *ideas*; and ſo we make uſe of theſe *words* inſtead of the *ideas* themſelves, even when we would meditate and reaſon within ourſelves, and make tacit *mental propoſitions*.

216. We muſt then obſerve two ſorts of *propoſitions* that we are capable of making: Firſt, *Mental propoſitions*, wherein the *ideas* in our underſtandings are put together or ſeparated by the mind perceiving or judging of their agreement or diſagreement. Secondly, *Verbal propoſitions*; which are words put together or ſeparated in affirmative or negative ſentences: ſo that *propoſition* conſiſts in joining or ſeparating ſigns; and *truth* conſiſts in putting together or ſeparating theſe ſigns, according as the things they ſtand for agree or diſagree.

217.

Knowledge of Existence.

217. Truth, as well as knowledge, may well come under the distinction of *verbal* and *real;* that being only *verbal truth*, wherein terms are joined according to the agreement or disagreement of the *ideas* they stand for, without regarding whether our *ideas* are such as really have or are capable of having an existence in nature. But then it is they contain *real truth*, when these signs are joined as our *ideas* agree: and when our ideas are such as, we know, are capable of having an existence in nature; which in substances we cannot know, but by knowing that such have existed. *Truth* is the marking down in words the agreement or disagreement of *ideas* as it is; *falsehood* is the marking down in words the agreement or disagreement of *ideas* otherwise than it is: and so far as these *ideas*, thus marked by sounds, agree to their *archetypes*, so far only is the *truth real*. The knowledge of this *truth* consists in knowing what *ideas* the words stand for, and the perception of the agreement or disagreement of those *ideas* according as it is marked by those words.

218. Besides *truth* taken in the strict sense before mentioned, there are other sorts of *truths:* As, first, *Moral truth;* which is speaking of things according to the persuasion of our own minds. Secondly, *Metaphysical truth;* which is nothing but the real existence of things conformable to the *ideas* to which we have annexed their names.

219. These considerations of *truth* either having been before taken notice of, or not being much to our present purpose, it may suffice here only to have mentioned them.

SECT. XXXIV. *Of our Knowledge of Existence.*

220. HITHERTO we have only considered the *essences* of things; which being only *abstract ideas*, and thereby removed in our thoughts from particular existence, give us no knowledge of *existence* at all. We proceed now to inquire concerning our *knowledge of the existence* of things, and how we come by it.

221. We have the knowledge of our *own existence* by *intuition;* of *the existence of God*, by *demonstration;* and of *other things*, by *sensation*. As for our *own existence*, we perceive it so plainly, that it neither needs, nor is capable of any proof. *I think, I reason, I feel pleasure and pain:* can any of these be more evident to me than my *own existence?* If I doubt of all other things, that very *doubt* makes me perceive my *own existence*, and will not suffer me to doubt of that. If I know I doubt, I have as certain a perception of the *thing* doubting, as of that *thought* which I call *doubt*. Experience then convinces us, that we have an *intuitive knowledge of our own existence*, and an internal infallible perception that we *are*. In every act of sensation, reasoning, or thinking, we are conscious to ourselves of our own being; and in this matter come not short of the highest degree of certainty.

SECT. XXXV. *Of our Knowledge of the Existence of a God.*

222. THOUGH *God* has given us no *innate ideas* of himself, yet having furnished us with those faculties our minds are endowed with, he hath not *left himself without a witness*, since we have sense, perception, and reason, and cannot want a clear proof of him as long as we carry ourselves about us. Nor can we justly complain of our ignorance in this great point, since he has so plentifully provided us with means to discover and know him, so far as is necessary to the end of our being, and the great concernment of our happiness. But though this be the most obvious truth that reason discovers, yet it requires thought and attention; and the mind must apply itself to a regular deduction of it, from some part of our *intuitive* knowledge; or else we shall be as ignorant of this, as of other propositions which are in themselves capable of clear demonstration. To shew, therefore, that we are capable of knowing, that is, *being certain*, that *there is a God*, and how we may come by this certainty, we need go no farther than ourselves, and that undoubted knowledge we have of our own *existence*. It is beyond question, that *man has a clear perception of his own being*: He knows certainly that he exists, and that he is something. In the next place, man knows by an *intuitive* certainty, that *bare nothing can no more produce any real being, than it can be equal to two right angles*. If therefore we know there is some real being, it is an evident demonstration, that *from eternity there has been something;* since what was not from eternity had a beginning, and what had a beginning must be produced by something else. Next, it is evident, that *what has its being from another, must also have all that which is in and belongs to its being from another too:* All the powers it has, must be owing to, and received from, the same source. This eternal source then of all being must be also the source and original of all power; and so this *eternal being* must be also the *most powerful*.

Existence of a God.

223. Again, man finds in himself *perception* and *knowledge:* We are certain, then, that there is not only some being, but some knowing intelligent being in the world. There was a time, then, when there was no knowing being, or else there has been a knowing being from eternity. If it be said, there was a time when that eternal being had no knowledge; the reply is, that then it is impossible there should have ever been any knowledge; it being as impossible that things wholly void of knowledge, and operating blindly and without any perception, should produce a knowing being, as it is that a triangle should make itself three angles bigger than two right ones.

224 This from the consideration of ourselves, and what we infallibly find in our own constitutions, our reason leads us to the knowledge of this certain and evident truth, that *there is an eternal, most powerful and knowing being;* and from this *idea* duly considered, will easily be deduced all those other *attributes* we ought to ascribe to this *eternal being*.

225. From what has been said, it is plain, we have a more certain knowledge of the existence of a *God* than of any thing our senses have not immediately discovered to us; nay, that we more certainly know that there is a *God*, than that there is any thing else without us.

226. It being then unavoidable for all rational creatures to conclude, that *something has existed from eternity;* let us next see what *kind of thing* that must be. There are but two sorts of beings in the world, that man knows or conceives. First, Such as are purely material, without sense or preception, as the clippings of our beards, and parings of our nails.

Secondly,

Exiſtence of a God.

Secondly, Senſible perceiving beings; ſuch as we find ourſelves to be. Theſe two ſorts we ſhall hereafter call *cogitative* and *incogitative* beings; which to our preſent purpoſe are better than *material* and *immaterial*.

228. If then there muſt be ſomething *eternal*, it is very obvious to reaſon, that it muſt neceſſarily be a *cogitative* being; becauſe it is as impoſſible to conceive that ever bare *incogitative* matter ſhould produce a *thinking* intelligent being, as that nothing ſhould of itſelf produce matter. Let us ſuppoſe any parcel of matter *eternal*, we ſhall find it in itſelf unable to produce any thing. Let us ſuppoſe its parts firmly at reſt together: If there were no other being in the world, muſt it not eternally remain ſo, a dead unactive lump? Is it poſſible to conceive it can add motion to itſelf, or produce any? *Matter* then by its own ſtrength cannot produce in itſelf ſo much as *motion*. The motion it has muſt alſo be from eternity, or elſe added to matter by ſome other being more powerful than matter. But let us ſuppoſe motion eternal too; yet matter, *incogitative* matter and motion, could never produce *thought*. *Knowledge* will ſtill be as far beyond the *power* of *motion* and *matter* to produce, as matter is beyond the power of nothing to produce. Divide *matter* into as minute parts as you will, vary the figure and motion of it as much as you pleaſe, it will operate no otherwiſe upon other bodies of proportionable bulk than it did before this diviſion. The minuteſt particles of matter knock, impel, and reſiſt one another, juſt as the greater do; and that is all they can do. So that if we will ſuppoſe *nothing eternal*, *matter can never begin to be:* If we ſuppoſe *bare matter* without motion *eternal*, *motion can never begin to be:* If we ſuppoſe only matter and motion *eternal*, *thought can never begin to be:* For it is impoſſible to conceive that matter, either with or without motion, could have originally, in and from itſelf, ſenſe, perception, and knowledge; as is evident from hence, that then ſenſe, perception, and knowledge, muſt be a property eternally inſeparable from matter and every particle of it. Since, therefore, whatſoever is the firſt eternal being, muſt neceſſarily be *cogitative;* and whatſoever is firſt of all things, muſt neceſſarily contain in it, and actually have, at leaſt all the perfections that can ever after exiſt; it neceſſarily follows, that the *firſt eternal being cannot be matter*.

229. If therefore it be evident that ſomething neceſſarily muſt exiſt from eternity, it is alſo evident that that *ſomething muſt neceſſarily be a cogitative being:* For it is as impoſſible that *incogitative matter* ſhould produce a *cogitative being*, as that nothing, or the negation of all being, ſhould produce a poſitive being or matter.

230. This diſcovery of the neceſſary exiſtence of an Eternal Mind, does ſufficiently lead us into the knowledge of God. For it will hence follow, that all other knowing beings that have a beginning muſt depend on him, and have no other ways of knowledge or extent of power than what he gives them; and therefore if he made thoſe, he made alſo the leſs excellent pieces of this univerſe, all *inanimate bodies*, whereby his *omniſcience*, *power*, and *providence*, will be eſtabliſhed; and from thence all his other attributes neceſſarily follow.

Sect. XXXVI. *Of our Knowledge of the Exiſtence of other Things.*

Knowledge of other Exiſtences.

231. The knowledge of our own being we have by *intuition:* The exiſtence of a God, *reaſon* clearly makes known to us. The *knowledge of the exiſtence* of any other thing, we can have only by *ſenſation:* For there being no neceſſary connection *of real exiſtence* with any idea a man hath in his memory; nor of any other exiſtence, but that of God, with the exiſtence of any particular man; no particular man can know the exiſtence of any other being, but only when, by actually operating upon him, it makes itſelf be perceived by by him. The having the idea of any thing in our mind, no more proves the exiſtence of that thing, than the picture of a man evidences his being in the world, or the viſions of a dream make thereby a true hiſtory. It is therefore the actual receiving of ideas from without, that gives us notice of the exiſtence of other things, and makes us know that ſomething doth exiſt at that time without us, which cauſes that idea in us, though perhaps we neither know nor conſider how it does it; for it takes not from the *certainty* of our ſenſes, and the ideas we receive by them, that we know not the manner wherein they are produced. This notice we have by our ſenſes of the exiſting of things without us, though it be not altogether ſo certain as *intuition* and *demonſtration*, deſerves the name of *knowledge*, if we perſuade ourſelves that our faculties act and inform us right concerning the exiſtence of thoſe objects that affect them. But beſides the aſſurance we have from our ſenſes themſelves, that they do not err in the information they give us of the exiſtence of things without us, we have other concurrent reaſons: As, 1. It is plain thoſe perceptions are produced in us by exterior cauſes affecting our ſenſes, becauſe thoſe that want the *organs* of any *ſenſe* never can have the *ideas* belonging to that ſenſe prodouced in their minds. This is too evident to be doubted; and therefore we cannot but be aſſured, that they come in by the organs of that ſenſe, and no other way.

Secondly, Becauſe we find ſometimes that we cannot avoid the having thoſe *ideas* produced in our minds. When my eyes are ſhut, I can with pleaſure recall to my mind the *ideas* of *light* or the *ſun*, which former ſenſations had lodged in my memory: But if I turn my eyes towards the *ſun*, I cannot avoid the *ideas* which the *light* or the *ſun* then produces in me. Which ſhews a manifeſt difference between thoſe *ideas* laid up in the memory, and ſuch as force themſelves upon us and we cannot avoid having. And therefore it muſt needs be ſome *exterior* cauſe, whoſe efficacy I cannot reſiſt, that produces thoſe *ideas* in my mind whether I will or no.

233. Beſides, there is nobody who doth not perceive the difference in himſelf, between actually looking upon the *ſun*, and contemplating the *idea* he has of it in his memory; and therefore he hath certain knowledge, that they are not both memory or fancy, but that actual ſeeing has a cauſe without.

234. Thirdly, add to this, that many *ideas* are produced in us with pain, which we afterwards remember without the leaſt offence. Thus the pain of *heat* or *cold*, when the *idea* of it is received in our minds, gives

Existence. us no disturbance, which, when felt, was very troublesome; and we remember the pain of *hunger*, *thirst*, *head-ach*, &c. without any pain at all, which would either never disturb us, or else constantly do it as often as we thought of it, were there nothing more but *ideas* floating in our minds, and appearances entertaining our fancies, without the real existence of things affecting us from abroad.

235. *Fourthly*, Our *senses* in many cases bear witness to the truth of each other's report concerning the existence of sensible things without us: he that doubts when he sees a *fire*, whether it be *real*, may, if he please, feel it too; and by the exquisite pain he will be convinced, that it is not a bare *idea* or *phantom*.

236. If, after all this, any one will be so *sceptical* as to distrust his senses, and to question the existence of all things, or our knowledge of any thing, let him consider that the certainty of things existing *in rerum natura*, when we have the testimony of our senses for it, is not only as great as our frame can attain to, but as our condition needs. For our *faculties* being not suited to the full extent of being, nor a clear comprehensive knowledge of all things, but to the preservation of us in whom they are, and accommodated to the use of life; they serve our purpose well enough, if they will but give us certain notice of those things that are convenient or inconvenient to us. For he that sees a *candle* burning, and has experimented the force of the flame by putting his finger in it, will little doubt that this is something existing without him which does him harm and puts him to pain: which is assurance enough; when no man requires greater certainty to govern his actions by, than what is as certain as his actions themselves. So that this evidence is as great as we can desire, being as certain to us as our pleasure or pain, that is, *happiness* or *misery*; beyond which we have no concernment either of knowing or being.

237. In fine, when our *senses* do actually convey into our understandings any *idea*, we are assured that there is something at that time *really existing* without us. But this knowledge extends only as far as the present testimony of our senses, employed about particular objects that do then affect them, and no farther. My seeing a *man* a minute since, is no certain argument of his present existence.

238. As when our *senses* are actually employed about any object, we know that it does exist; so by our memory we may be assured, that heretofore things that affected our *senses have existed:* And thus we have the knowledge of the past existence of several things, whereof our senses having informed us, our memories still retain the *ideas;* and of this we are past all doubt, so long as we remember well.

239. As to the *existence* of *spirits*, our having *ideas* of them does not make us know that any such things do exist without us, or that there are any *finite spirits*, or any other *spiritual beings* but the *eternal God*. We have ground from *revelation*, and several other reasons, to believe with assurance, that there are such creatures: But our senses not being able to discover them, we want the means of knowing their particular existence; for we can no more know that there are *finite spirits* really existing, by the *ideas* we have of such beings, than by the *ideas* any one has of *fairies*, or *centaurs*, he can come to know, that things answering those *ideas* do really exist.

240. Hence we may gather, that there are *two sorts* of propositions: *One* concerning the existence of any thing answerable to such an *idea*, as that of an *elephant*, *phœnix*, *motion*, or *angel*, *viz.* whether such a thing does any where exist: And this knowledge is only of *particulars*, and not to be had of any thing without us, but only of *God*, any other way than by our *senses*.

241. *Another sort* of proposition is, wherein is expressed the agreement or disagreement of our *abstract ideas*, and their dependence one on another. And these may be *universal* and certain: so having the *idea* of *God* and my *self*, of *fear* and *obedience*, I cannot but be sure that *God is to be feared and obeyed by me:* and this proposition will be certain concerning *man* in general, if I have made an *abstract idea* of such a *species*, whereof I am one particular. But such a proposition, how certain soever, proves not to me the existence of men in the world; but will be true of all such creatures, whenever they do exist: which *certainty* of such general propositions depends on the agreement or disagreement discoverable in those *abstract ideas*. In the former case, our knowledge is the consequence of the *existence of things* producing *ideas* in our minds by our senses: in the latter, the consequences of the *ideas* that *are in our minds*, and producing these general propositions, many whereof are called *eternæ veritates:* and all of them indeed are so; not from being written all or any of them in the minds of all men, or that they were any of them propositions in any one's mind, till he, having got the *abstract ideas*, joined or separated them by affirmation or negation; but wheresoever we can suppose such a creature as *man* is, endowed with such faculties, and thereby furnished with such *ideas* as we have, we must conclude he must needs, when he applies his thoughts to the consideration of his *ideas*, know the truth of certain propositions that will arise from the agreement or disagreement he will perceive in his own *ideas*. Such propositions being once made about *abstract ideas*, so as to be true, they will, whenever they can be supposed to be made again, at any time past, or to come, by a mind having those *ideas*, always be true: for names being supposed to stand perpetually for the same *ideas*, and the same *ideas* having immutably the same habitudes one to another, propositions concerning any *abstract ideas* that are once true must needs be *eternal verities*.

Sect. XXXVII. *Of Judgment.*

242. The *understanding faculties* being given to man, not barely for speculation, but also for the conduct of his life, a man would be at a great loss, if he had nothing to direct him but what has the certainty of true knowledge. He that will not *eat* till he has demonstration that it will nourish him, nor *stir* till he is infallibly assured of success in his business, will have little else to do but *sit still, and perish*. Judgment.

243. Therefore as *God* hath set some things in broad *day-light;* as he has given us some certain knowledge, though limited to a few things in comparison, (probably

Probability.

(probably as a taſte of what *intellectual* creatures are capable of, to excite in us a deſire and endeavour after a better ſtate;) ſo, in the greateſt part of our concernment, he has afforded us only the *twilight* of *probability*, ſuitable to that ſtate of *mediocrity* and *probationerſhip* he has been pleaſed to place us in here.

244. The faculty which *God* has given *man* to enlighten him, next to certain knowledge, is *judgment*; whereby the mind takes its *ideas* to agree or diſagree, without perceiving a demonſtrative evidence in the proofs. The mind exerciſes this judgment ſometimes out of *neceſſity*, where demonſtrative proofs and certain knowledge are not to be had; and ſometimes out of *lazineſs*, unſkilfulneſs, or haſte, even where they are to be had.

245. This faculty of the mind, when it is exerciſed immediately about things, is called *judgment:* when about truths delivered in words, is moſt commonly called *aſſent* or *diſſent*. Thus the mind has *two faculties* converſant about truth and falſehood: Firſt, *Knowledge;* whereby it certainly perceives, and is undoubtedly ſatisfied of the agreement or diſagreement of any ideas. Secondly, *Judgment;* which is the putting *ideas* together, or ſeparating them from one another in the mind, when their certain agreement or diſagreement is not *perceived*, but preſumed to be ſo. And if it ſo unites or ſeparates them as in reality things are, it is *right judgment.*

Sect. XXXVIII. *Of Probability.*

246. Probability is nothing but the appearance of the agreement or diſagreement of two *ideas*, by the intervention of proofs, whoſe connection is not conſtant and immutable, or is not perceived to be ſo; but is or appears for the moſt part to be ſo; and is enough to induce the mind to judge the propoſition to be *true* or *falſe*, rather than the contrary.

247. Of *probability* there are degrees, from the neighbourhood of *certainty* and *demonſtration*, quite down to *improbability* and *unlikelineſs*, even to the confines of *impoſſibility:* And alſo degrees of *aſſent*, from *certain knowledge*, and what is next it, *full aſſurance* and *confidence*, quite down to *conjecture*, *doubt*, *diſtruſt*, and *diſbelief.*

248. That propoſition then is *probable*, for which there are arguments or proofs to make it paſs or be received for *true:* The entertainment the mind gives to this ſort of propoſitions, is called *belief*, *aſſent*, or *opinion*. *Probability* then being to ſupply the defect of our knowledge, is always converſant about propoſitions whereof we have no *certainty*, but only ſome *inducements* to receive them for true. The *grounds* of it are, in ſhort, *theſe two* following.

Firſt, The *conformity* of any thing with our own knowledge, experience, or obſervation.

Secondly, The *teſtimony* of others, vouching their obſervation and experience. In the *teſtimony* of others is to be conſidered, *Firſt*, The number; *Secondly*, The integrity; *Thirdly*, The ſkill of the witneſſes; *Fourthly*, The deſign of the author, if it be a teſtimony cited out of a book; *Fifthly*, The conſiſtency of the parts and circumſtances of the relation; *Sixthly*, Contrary teſtimonies.

249. The mind, before it rationally *aſſents* or *diſſents* to any probable propoſition, ought to examine all the grounds of *probability*, and ſee how they make, more or leſs, for or againſt it; and upon a due balancing of the whole, reject or receive it, with a more or leſs firm *aſſent*, according to the preponderancy of the greater *grounds* of *probability* on one ſide or the other.

Degrees of Aſſent.

Sect. XXXIX. *Of the Degrees of Aſſent.*

250. The *grounds of probability*, laid down in the foregoing ſection, as they are the foundations on which our *aſſent* is built, ſo are they alſo the meaſure whereby its ſeveral *degrees* are (or ought to be) regulated. Only we are to take notice, that no grounds of probability operate any farther on the mind, which ſearches after truth, and endeavours to judge right, than they appear, at leaſt, in the firſt judgment or ſearch that the mind makes. It is indeed in many caſes impoſſible, and in moſt very hard, even for thoſe who have admirable memories, to retain all the proofs which, upon a due examination, made them embrace that ſide of the queſtion. It ſuffices that they have once, with care and fairneſs, ſifted the matter as far as they could; and having once found on which ſide the *probability* appeared to them, they lay up the concluſion in their memories, as a *truth* they have diſcovered; and for the future remain ſatisfied with the teſtimony of their memories, that this is the opinion, that, by the proofs they have once ſeen of it, deſerves ſuch a *degree* of their *aſſent* as they afford it.

251. It is unavoidable then that the memory be relied on in this caſe, and that men be perſuaded of ſeveral *opinions*, whereof the proofs are not actually in their thoughts, nay, which perhaps they are not able actually to recall: without this the greateſt part of men muſt be either *ſceptics*, or change every moment, when any one offers them arguments which, for want of memory, they are not preſently able to anſwer.

252. It muſt be owned, that mens ſticking to paſt judgments, is often the cauſe of great *obſtinacy* in error and miſtake. But the fault is not that they rely on their memories for what they have before well judged, but becauſe they judged before they had well examined. Who almoſt is there that hath the leiſure, patience, and means, to collect together all the proofs concerning moſt of the opinions he has, ſo as ſafely to conclude, that he has a clear and full view, and that there is no more to be alleged for his better information? And yet we are forced to determine ourſelves on one ſide or other: the conduct of our lives, and the management of our great concerns, will not bear delay: For thoſe depend, for the moſt part, on the determination of our judgment in points wherein we are not capable of certain knowledge, and in where it is neceſſary for us to embrace one ſide or the other.

253. The propoſitions we receive upon inducements of *probability are of two ſorts: Firſt*, Concerning ſome particular exiſtence, or matter of *fact*, which falling under our obſervation, is capable of *human teſtimony: Secondly*, Concerning things which, being beyond the diſcovery of our *ſenſes*, are not capable of human teſtimony.

Concerning the firſt of theſe, *viz. Particular matter of fact.*

254. *Firſt*, Where any particular thing conſonant to the conſtant obſervation of ourſelves, and others, in the like caſe, comes atteſted with the concurrent reports

Degrees of Assent.

ports of all that mention it, we receive it as easily, and build as firmly upon it, as if it were certain knowledge. Thus, if all *Englishmen*, who have occasion to mention it, should report, that it *froze* in England last winter, or the like, a man would as little doubt of it, as that *seven and four are eleven*.

255. The *first* and *highest* degree of *probability* then is, when the general consent of all men, in all ages, as far as can be known, concurs with a man's own constant experience in the like cases, to confirm the truth of any particular matter of fact, attested by fair witnesses. Such are the stated *constitutions* and *properties* of bodies, and the regular proceedings of *causes* and *effects* in the ordinary course of *nature*. This we call an *argument* from the nature of things themselves: For what we and others always observe to be after the same manner, we conclude with reason to be the effects of steady and regular *causes*, though they come not within the reach of our knowledge; as that fire warmed a man, or made *lead fluid*; that *iron* sunk in water, or swam in quicksilver. A relation affirming any such thing to have been, or a predication that it will happen again in the same manner, is received without doubt or hesitation; and our *belief* thus grounded, rises to *assurance*.

256. *Secondly*, The next degree of *probability*, is when by my own experience, and the agreement of all others that mention it, a *thing* is found to be for the most part so; and that the particular instance of it is attested by many and undoubted *witnesses*. Thus *history* giving us such an account of men in all ages, and my own experience confirming it, that most men prefer their own private advantage to the public; if all historians that write of *Tiberius*, say that he did so, it is extremely probable: And in this case, our *assent* rises to a degree which we may call *confidence*.

257. *Thirdly*, In matters happening indifferently, as that a *bird* should fly this or that way; when any particular matter of fact comes attested by the concurrent testimony of unsuspected *witnesses*, there our *assent* is also unavoidable. Thus, that there is in *Italy* such a city as *Rome*; that about one thousand and eight hundred years ago there lived such a man in it as *Julius Cæsar*, &c. a man can as little doubt of this, and the like, as he does of the being and actions of his own acquaintance, whereof he himself is a witness.

258. *Probability*, on these grounds, carries so much evidence with it, that it leaves us as little liberty to believe or disbelieve, as demonstration does, whether we will know or be ignorant. But the difficulty is, when testimonies contradict common experience, and the reports of witnesses clash with the ordinary course of nature, or with one another; here diligence, attention, and exactness, is required to form a *right judgment*, and to proportion the *assent* to the evidence and *probability* of the thing, which rises and falls according as the two foundations of credibility favour or contradict it. These are liable to such variety of contrary observations, circumstances, reports, tempers, designs, oversight, &c. of reporters, that it is impossible to reduce to precise rules the various degrees wherein men give their *assent*. This in general may be said, that as the *proofs*, upon due examination, shall to any one appear in a greater or less degree to preponderate on either side, so they are fitted to produce in the mind such different entertainments, as are called *belief*, *conjecture*, *guess*, *doubt*, *wavering*, *distrust*, *disbelief*, &c.

Degrees of Assent.

259. It is a *rule* generally approved, that any testimony, the farther off it is removed from the original truth, the less force it has: and in *traditional* truths, each remove weakens the force of the *proof*. There is a *rule* quite contrary to this, advanced by some men, who look on *opinions* to gain force by growing *older*. Upon this ground, propositions evidently false or doubtful in their first beginning, come by an inverted *rule* of *probability* to pass for *authentic* truths; and those which deserved little credit from the mouths of their first relators, are thought to grow *venerable* by age, and are urged as undeniable.

260. But certain it is, that no *probability can rise above its first original*. What has no other evidence than the single testimony of *one witness*, must stand or fall by his *only* testimony, though afterwards cited by hundreds of others; and is so far from receiving any strength thereby, that it becomes the weaker; because passion, interest, inadvertency, mistake of his meaning, and a thousand odd reasons, which capricious mens minds are acted by, may make one man quote another's words or meaning wrong. This is certain, that what in one age was affirmed upon slight grounds, can never after come to be more valid in future ages by being often repeated.

261. *The second sort of probability*, is concerning things not falling under the reach of our senses, and therefore not capable of testimony: and such are,

262. (1.) The existence, nature, and operations of *finite immaterial* beings without us, as *spirits*, *angels*, &c. or the existence of *material* beings, such as, for their smallness or remoteness, our *senses* cannot take notice of; as whether there be any *plants*, *animals*, &c. in the *planets*, and other mansions of the vast universe.

263. (2.) Concerning the manner of operation in most parts of the works of *nature*; wherein though we see the sensible *effects*, yet their causes are unknown, and we perceive not the ways and manner how they are produced. We see *animals* are generated, nourished, and move; the *loadstone* draws *iron*, &c. But the causes that operate, and the manner they are produced, we can only guess, and probably conjecture. In these matters *analogy* is the only help we have; and it is from that alone we draw all our grounds of *probability*. Thus observing, that the bare rubbing of two bodies violently upon one another, produces *heat*, and very often *fire*, we have reason to think, that what we call *heat* and *fire* consists in a certain violent agitation of the imperceptible minute parts of the burning matter.

This sort of *probability*, which is the best conduct of rational experiments, and the rise of *hypotheses*, has also its use and influence. And a wary reasoning from *analogy* leads us often into the discovery of *truths* and useful *deductions*, which would otherwise lie concealed.

264. Though the common experience, and the ordinary course of things, have a mighty influence on the minds of men, to make them give or refuse credit to any thing proposed to their belief; yet there is one case wherein the strangeness of the fact lessens not the *assent* to a fair testimony given of it. For where such supernatural *events* are suitable to ends aimed at by

Reason. Him who has the power to change the courſe of nature, there, under ſuch circumſtances, they may be the fitter to procure belief, by how much the more they are beyond or contrary to ordinary obſervation. This is the proper caſe of *miracles;* which, well atteſted, do not only find credit themſelves, but give it alſo to other *truths.*

265. There are propoſitions that challenge the higheſt degree of our *aſſent* upon bare teſtimony, whether the thing propoſed agree or diſagree with common experience and the ordinary courſe of things or no: the reaſon whereof is, becauſe the teſtimony is of ſuch *an one* as cannot deceive nor be deceived; and that is *God* himſelf. This carries with it certainty beyond doubt, evidence beyond exception. This is called by a peculiar name, *revelation,* and our *aſſent* to it, *faith,* which has as much certainty in it as our knowledge itſelf; and we may as well doubt of our own *being,* as we can whether any *revelation* from *God* be *true.* So that *faith* is a ſettled and ſure principle of *aſſent* and *aſſurance,* and leaves no manner of room for doubt or heſitation; only we muſt be ſure, that it be a divine *revelation,* and that we underſtand it right, elſe we ſhall expoſe ourſelves to all the extravagancy of *enthuſiaſm,* and all the error of wrong principles, if we have *faith* and *aſſurance* in what is not *divine revelation.*

Sect. XL. *Of Reaſon.*

266. The word *reaſon,* in *Engliſh,* has different ſignifications. Sometimes it is taken for *true* and *clear principles;* ſometimes for *clear* and *fair deductions* from thoſe principles; ſometimes for the *cauſe,* and particularly for the *final cauſe:* but the conſideration we ſhall have of it here, is as it ſtands for a *faculty* whereby *man* is ſuppoſed to be diſtinguiſhed from *beaſts,* and wherein it is evident he much ſurpaſſes them.

267. Reaſon is neceſſary, both for the enlargement of our knowledge and regulating our aſſent; for it hath to do both in knowledge and opinion, and is neceſſary and aſſiſting to all our other intellectual faculties; and indeed contains *two* of them, *viz.* firſt, *Sagacity,* whereby it finds intermediate *ideas;* ſecondly, *Illation,* whereby it ſo orders and diſpoſes of them, as to diſcover what connection there is in each link of the chain, whereby the extremes are held together, and thereby, as it were, to draw into view the truth ſought for; which is that we call *illation,* or *inference,* and conſiſts in nothing but the perception of the connection there is between the *ideas* in each ſtep of the deduction; whereby the mind comes to ſee either the certain agreement or diſagreement of any two *ideas,* as in *demonſtration,* in which it arrives at knowledge; or their probable connection, on which it gives or withholds its *aſſent,* as in *opinion.*

268. *Senſe* and *intuition* reach but a little way: the greateſt part of our knowledge depends upon deductions and intermediate *ideas.* In thoſe caſes where we muſt take propoſitions for true, without being certain of their being ſo, we have need to find out, examine, and compare the grounds of their probability: in both caſes, the faculty which finds out the means, and rightly applies them to diſcover certainty in the one, and probability in the other, is that which we call *reaſon:* ſo that in reaſon we may conſider theſe *four* degrees; *Firſt,* The diſcovering and finding out of proofs. *Secondly,* The regular and methodical diſpoſition of them, and laying them in ſuch order as their connection may be plainly perceived. *Thirdly,* The perceiving their connection. *Fourthly,* The making a right concluſion.

Reaſon. 269. There is one thing more which deſerves to be conſidered concerning *reaſon;* and that is, whether *ſyllogiſm,* as is generally thought, be the proper inſtrument of it, and the uſefulleſt way of exerciſing this faculty. The cauſes to doubt of it, are theſe:

270. *Firſt,* Becauſe *ſyllogiſm* ſerves our *reaſon* but in one only of the forementioned parts of it; and that is, to ſhew the connection of the proofs of any one inſtance, and no more: but in this it is of no great uſe, ſince the mind can perceive ſuch connection, where it really is, as eaſily, nay perhaps better, without it. We may obſerve, that there are many men that reaſon exceeding clear and rightly, who know not how to make a *ſyllogiſm;* and ſcarce any one make *ſyllogiſms* in reaſoning within himſelf. Indeed, ſometimes they may ſerve to diſcover a fallacy, hid in a *rhetorical* flouriſh; or, by ſtripping an abſurdity of the cover of wit and good language, ſhew it in its naked deformity: but the weakneſs or fallacy of ſuch a looſe diſcourſe it ſhews, by the artificial form it is put into, only to thoſe who have thoroughly ſtudied *mode* and *figure,* and have ſo examined the many ways that three propoſitions may be put together, as to know which of them does certainly conclude right, and which not, and upon what grounds it is that they do ſo: but they who have not ſo far looked into thoſe forms, are not ſure, by virtue of *ſyllogiſm,* that the concluſion certainly follows from the premiſſes; the mind is not taught to reaſon by theſe *rules;* it has a native faculty to perceive the coherence or incoherence of its *ideas,* and can range them right without any ſuch perplexing *repetitions.*

271. And to ſhew the weakneſs of an argument, there needs no more but to ſtrip it of the ſuperfluous *ideas,* which, blended and confounded with thoſe on which the inference depends, ſeem to ſhew a connection where there is none, or at leaſt do hinder the diſcovery of the want of it; and then to lay the naked *ideas,* on which the force of the argumentation depends, in their due order; in which poſition the mind, taking a view of them, ſees what connection they have, and ſo is able to judge of the inference without any need of ſyllogiſm at all.

272. *Secondly,* Becauſe ſyllogiſms are not leſs liable to fallacies than the plainer ways of argumentation. And for this we appeal to common obſervation, which has always found theſe artificial methods of reaſoning more adapted to catch and entangle the mind, than to inſtruct and inform the underſtanding. And if it be certain that fallacy can be couched in ſyllogiſms, as it cannot be denied, it muſt be ſomething elſe, and not ſyllogiſm, that muſt diſcover them: but if men ſkilled in and uſed to ſyllogiſms, find them aſſiſting to their reaſon in the diſcovery of truth, we think they ought to make uſe of them. All that we aim at is, that they ſhould not aſcribe more to theſe forms than belongs to them; and think that men have no uſe, or not ſo full a uſe, of their reaſoning faculty without them.

273. But however it be in knowledge, it is of far leſs, or no uſe at all in *probabilities:* for the *aſſent* there being to be determined by the preponderancy, after a due weighing of all the proofs on both ſides, nothing is

Reason. is so unfit to assist the mind in that as *syllogism;* which running away with one assumed *probability*, pursues that till it has led the mind quite out of sight of the thing under consideration.

274. But let it help us (as perhaps may be said) *in convincing men of their errors or mistakes:* yet still it fails our reason in that part, which if not its highest perfection, is yet certainly its hardest task, and that which we most need its help in; and that is, the *finding out of proofs and making new discoveries*. This way of reasoning discovers no new proofs, but is the art of marshalling and ranging the old ones we have already. A man knows first, and then he is able to prove *syllogistically;* so that *syllogism* comes after knowledge; and then a man has little or no need of it. But it is chiefly by the finding out those *ideas* that shew the connection of distant ones, that our stock of knowledge is increased, and that useful arts and sciences are advanced.

275. *Reason*, though of a very large extent, fails us in several instances; as, *first*, Where our ideas fail. *Secondly*, It is often at a loss, because of the obscurity, confusion, or imperfection of the *ideas* it is employed about. Thus having no perfect *idea* of the least extension of *matter*, or of *infinity*, we are at a loss about the divisibility of *matter*. *Thirdly*, Our *reason* is often at a stand, because it perceives not those *ideas* which would serve to shew the certain or probable agreement or disagreement of any two other *ideas*. *Fourthly*, Our *reason* is often engaged in absurdities and difficulties, by proceeding upon false principles, which being followed lead men into contradictions to themselves, and inconsistency in their own thoughts. *Fifthly*, Dubious words, and uncertain signs, often puzzle mens *reason*, and bring them to a nonplus.

276. Though the deducing one proposition from another be a great part of reason, and that which it is usually employed about; yet the principal act of ratiocination, is the finding the agreement or disagreement of two *ideas* one with another, by the intervention of a third; as a man, by a yard, finds two houses to be of the same length, which could not be brought together to measure their equality by *juxta-position:* words have their consequences as the signs of such *ideas:* and things agree or disagree, as really they are; but we observe it only by our *ideas*.

In reasoning, men ordinarily use *four* sorts of *arguments*.

277. The *first* is to allege the opinions of men, whose parts, learning, eminency, power, or some other cause, has gained a name, and settled their reputation in the common esteem with some kind of authority: this may be called *argumentum ad verecundiam*.

278. *Secondly*, Another way is, to require the adversary to admit what they allege as a proof, or to assign a better: this is called *argumentum ad ignorantiam*. Reason.

279. A *third* way, is to press a man with consequences drawn from his own principles or concessions: this is known under the name of *argumentum ad hominem*.

280. *Fourthly*, The using of proofs drawn from any of the foundations of knowledge or probability: this is called *argumentum ad judicium*. This alone, of all the four, brings true instruction with it, and advances us in our way to knowledge: for, first, It argues not another man's opinion to be right, because I, out of respect, or any other consideration but that of conviction, will not contradict him. Secondly, It proves not another man to be in the right way, nor that I ought to take the same with him, because I know not a better. Thirdly, Nor does it follow, that another man is in the right way, because he has shewn me that I am in the wrong: this may dispose me, perhaps, for the reception of truth, but helps me not to it; that must come from *proofs and arguments*, and light arising from the nature of things themselves; not from my shamefacedness, ignorance, or error.

281. By what has been said of *reason*, we may be able to make some guess at the distinction of things into those that are according to, above, and contrary to, *reason*. *According to reason*, are such propositions whose truth we can discover by examining and tracing those *ideas* we have from *sensation* and *reflection*, and by natural deduction find to be true or probable. *Above reason*, are such propositions, whose *truth* or *probability* we cannot by *reason* derive from those principles. *Contrary to reason*, are such propositions as are inconsistent with, or irreconcileable to, our clear and distinct *ideas*. Thus the *existence of one God*, is according to *reason;* the *existence of more than one God*, contrary to *reason;* the *resurrection of the body* after death, above *reason*. *Above reason*, may be also taken in a double sense, viz. *above probability*, or, *above certainty:* in that large sense also, *contrary to reason* is sometimes taken.

282. There is another use of the word *reason*, wherein it is opposed to *faith;* which, though authorised by common use, yet is in itself a very improper way of speaking: for *faith* is nothing but a firm *assent* of the mind; which, if it be regulated as is our duty, cannot be afforded to any thing but upon good *reason*, and so cannot be opposite to it: he that believes without having any reason for believing, may be in love with his own fancies; but neither seeks *truth* as he ought, nor pays the obedience due to his Maker, who would have him use those discerning faculties he has given him, to keep him out of mistake and error.

METAPLASMUS, in grammar, a transmutation or change made in a word, by adding, retrenching, or altering a syllable or letter thereof.

METAPONTUM, or METAPONTIUM, (anc. geog.), a town of Lucania, on the Sinus Tarentinus, to the west of Tarentum; built by the Pylians, who returned from Troy, (Mela). Where Pythagoras is said to have taught in the time of Servius Tullius, (Livy). *Metapontini*, the people; who pretended to shew, in a temple of Minerva, the tools with which Epeus built the wooden horse, (Justin). Now a tower, called *Torre di Mare*, in the Basilicata of Naples, (Baudrand).

METASTASIS, in medicine, a transposition, or settlement of some humour or disease on some other part; and sometimes it signifies such an alteration of a disease

difeafe as is fucceeded by a folution.

METATARSUS, in anatomy. See there, nº 69.

METATHESIS, in grammar, a fpecies of the metaplafmus; being a figure whereby the letters or fyllables of a word are tranfpofed, or fhifted out of their ufual fituations, as *piftris* for *priftis*, *Lybia* for *Libya*, &c.

This word is, by phyficians, ufed with refpect to morbific caufes; which, when they cannot be evacuated, are removed to places where they are lefs injurious.

METEMPSYCHOSIS, the doctrine of tranfmigration, which fuppofes, that human fouls, upon their leaving the body, become the fouls of fuch kind of brutes as they moft refemble in their manners.

This was the doctrine of Pythagoras and his followers, who held, that the fouls of vicious men were imprifoned in the bodies of miferable beafts, there to do penance for feveral ages, at the expiration whereof they returned again to animate men; but if they had lived virtuoufly, fome happier brute, or even a human creature, was to be their lot. What led Pythagoras into this opinion was the perfuafion he had that the foul was not of a perifhable nature; whence he concluded, that it muft move into fome other body upon its abandoning this. Lucan thinks this doctrine was contrived to mitigate the apprehenfion of death, by perfuading men that they only changed their lodgings, and ceafed to live only to begin a new life. Reuchlin denies this doctrine, and maintains, that the metempfychofis of Pythagoras implied nothing more than a fimilitude of manners and defires formerly exifting in fome perfon deceafed, and now reviving in another alive. Pythagoras is faid to have borrowed the notion of a metempfychofis from the Egyptians; others fay from the ancient brachmans. It is ftill retained among the ancient Banians, and other idolaters of India and China, and makes the principal foundation of their religion. Many of the modern Jews are faid to efpoufe this doctrine; and, to fupport their opinion, quote thefe words of Job, "Lo all thefe things worketh God oftentimes with man (in Hebrew, *and thrice*) to bring back his foul from the pit to be enlightened with the light of the living." It is certain, that at the time of Jefus Chrift this opinion was very common among the Jews: this appears in the gofpel, when they fay, that fome thought Jefus Chrift to be John the Baptift, others Elias, others Jeremiah, &c.

METEMPTOSIS, a term in chronology, expreffing the folar equation, neceffary to prevent the new moon from happening a day too late; by which it is oppofed to proemptofis, which fignifies the lunar equation neceffary to prevent the new moon from happening a day too foon. The new moon's running a little backward, that is, coming a day too foon, at the end of three hundred twelve years and a half; by the proemptofis a day is added every three hundred years, and another every two thoufand four hundred years. On the other hand, by the metemptofis, a biffextile is fuppreffed every one hundred and thirty-four years; that is, three times in four hundred years. Thefe alterations are never made but at the end of each century; that period being very remarkable, and rendering the practice of the kalendar eafy.

There are three rules for making this addition or fuppreffion of the biffextile day, and by confequence for changing the index of the epacts. 1. When there is a metemptofis, the next following, or lower index, muft be taken. 2. When there is a proemptofis without a metemptofis, the next preceding or fuperior index is to be taken. 3. When there are both a metemptofis and proemptofis, or when there is neither the one nor the other, the fame index is preferved.

METEOR, (by the Greeks called μετεωρα, q. d. *fublima*, or "high raifed;" by the Latins *impreffiones*, as making figns or impreffions in the air), commonly denotes any bodies in the air that are of a flux or tranfitory nature. Hence it is extended to the phenomena of hail, rain, fnow, thunder, &c.; but is moft commonly confined to thofe unufual and fiery appearances named *falling-ftars*, *ignes fatui*, *auroræ boreales*, &c. whether they appear at a great diftance from the earth or not. —Till the difcovery of electricity thefe meteors could not be accounted for: but they are now refolved, by the almoft univerfal confent of philofophers, into the action of that fluid; which, tho' unheeded, hath fhewed itfelf in all ages.

A luminous appearance, which muft have been of an electric nature, is mentioned by Plutarch in his life of Lyfander; who confiders it as a meteor. Pliny, in his fecond book of Natural Hiftory, calls thofe appearances *ftars;* and tells us, that they fettled not only upon the mafts, and other parts of fhips, but alfo upon mens heads. "Stars, fays he, make their appearance, both on land and fea. I have feen a light in that form on the fpears of foldiers keeping watch by night upon the ramparts. They are feen alfo on the fail-yards, and other parts of the fhips, making an audible found, and frequently changing their places. Two of thefe lights forebode good weather and a profperous voyage; and drive away the fingle one, which wears a threatening afpect. This the failors call *Helen;* but the two they call *Caftor* and *Pollux*, and invoke them as gods. Thefe lights do fometimes, about the evening, reft on mens heads, and are a great and good omen." Seneca, in his natural queftions, chap. 1. takes notice of the fame phenomenon. "A ftar (fays he) fettled on the lance of Gylippus, as he was failing to Syracufe: and fpears feemed to be on fire in the Roman camp." In Cæfar we find the fame appearances attending a violent ftorm. "About that time, (fays the author,) there was a very extraordinary appearance in the army of Cæfar. In the month of February, about the fecond watch of the night, there fuddenly arofe a thick cloud, followed by a fhower of ftones; and the fame night, the points of the fpears belonging to the fifth legion feemed to be on fire." Livy alfo mentions two fimilar facts. "The fpears of fome foldiers in Sicily, and a walking ftick which a horfeman in Sardinia was holding in his hand, feemed to be on fire. The fhores were alfo luminous with frequent fires."

Thefe appearances are called, both by the French and Spaniards inhabiting the coafts of the Mediterranean, *St Helme's* or *St Telme's fires;* by the Italians, the *fires of St Peter and St Nicholas;* and are frequently taken notice of by the writers of voyages. If fome late accounts from France are to be depended upon, this phenomenon has been obferved at Plauzet for time immemorial; and Mr Binon, the curate of the place,

fays,

fays, that for 27 years, during which he refided there, in great ftorms accompanied with black clouds, and frequent lightning, the three-pointed extremities of the crofs of the fteeple of that place appeared furrounded with a body of flame; and that when this phenomenon has been feen, the ftorm was no longer to be dreaded, and calm weather returned foon after.

Modern hiftory furnifhes a great many examples of a fimilar kind; but the moft remarkable of thefe terreftrial meteors, if they may be fo called, is the *ignis fatuus*, or, in common Englifh, *Will with a wifp*, to which the credulous vulgar afcribe very extraordinary and efpecially mifchievous powers. This phenomenon is chiefly vifible in damp places, and is alfo faid to be very often feen in burying grounds, and near dunghills. Travellers fay, that it is very frequent near Bologna in Italy, and in feveral parts of Spain and Ethiopia. The form and fize of it are very various, and often variable.

It was the opinion of many philofophers, and efpecially Willoughby and Ray, that the ignis fatuus is made by fhining infects; but this opinion was never well fupported. Sir Ifaac Newton calls it *a vapour fhining without heat*, and fuppofes that there is the fame difference between this vapour and flame, that there is between wood fhining without heat, and burning coals of fire. That this opinion is juft, and, moreover, that the light of this vapour fhining without heat is of the fame nature with light from putrefcent fubftances, may, according to Dr Prieftley, be concluded from the following circumftances relating to them, as defcribed by Dr Derham, and G. B. Beccari.

The former of thefe gentlemen, having obferved an ignis fatuus in fome boggy ground, between two rocky hills, in a dark and calm night, got by degrees within two or three yards of it, and thereby had an opportunity of viewing it to the greateft advantage. It kept fkipping about a dead thiftle, till a flight motion of the air, occafioned, as he fuppofed, by his near approach to it, made it jump to another place; and as he advanced, it kept flying before him. He was fo near to it, that, had it been the fhining of glow-worms, he was fatisfied that he could not but have diftinguifhed the feparate lights of which it muft have confifted; whereas it was one uniform body of light. He therefore thought that it muft be an ignited vapour. Similar in fome refpects to this light, was one that furrounded the body and the bed of a woman at Milan, which fled from the hand that approached it, but was at length difperfed by the agitation of the air.

Mr Beccari made it his bufinefs to inquire concerning this phenomenon of all his acquaintance, who had had opportunities of obferving it, either on the mountains, or on the plain. He found that two which appeared on the plains, one to the north, and the other to the eaft of Bologna, were to be feen almoft every dark night, efpecially the latter; and the light they gave was equal to that of an ordinary faggot. That to the eaft of Bologna once appeared to a gentleman of his acquaintance, as he was travelling, and kept him company above a mile, conftantly moving before him, and cafting a ftronger light upon the road than the torch which was carried along with him. All thefe luminous appearances, he fays, gave light enough to make all the neighbouring objects vifible, and they were always obferved to be in motion, but this motion was various and uncertain. Sometimes they would rife up, and at other times fink; but they commonly kept hovering about fix feet from the ground. They would alfo difappear of a fudden, and inftantly appear again in fome other place. They differed both in fize and figure, fometimes fpreading pretty wide, and then again contracting themfelves; fometimes breaking into two, and then joining again; fometimes floating like waves, and dropping, as it were, fparks of fire. He was affured that there was not a dark night all the year round in which they did not appear, and that they were obferved more frequently when the ground was covered with fnow, than in the hotteft fummer; nor did rain or fnow in the leaft hinder their appearance; but, on the contrary, they were obferved more frequently, and caft a ftronger light in rainy and wet weather; nor were they much affected by the wind.

The grounds to the eaft of Bologna, where the largeft of thefe appearances was feen, is, he fays, a hard chalky and clayey foil, which will retain the water a long time, and afterwards, in hot weather, would break into large cracks; but on the mountains, where the *ignes fatui* were fmaller, the foil was of a loofe fandy texture, which would not keep the water very long. According to the beft information he could procure, thefe lights very much frequent brooks and rivers, being often obferved on the banks of them; perhaps, he fays, becaufe the current of air carries them thither more readily than to any other place.

This gentleman concludes his account of thefe appearances with the following curious narrative. An intelligent gentleman travelling in March, between eight and nine in the evening, in a mountainous road, about ten miles fouth of Bologna, perceived a light, which fhone very ftrongly upon fome ftones which lay on the banks of the river Rioverde. It feemed to be about two feet above the ftones, and not far from the water. In fize and figure it had the appearance of a parallelopiped, fomewhat more than a foot in length, and half a foot high, the longeft fide being parallel to the horizon. Its light was fo ftrong, that he could plainly diftinguifh by it part of a neighbouring hedge, and the water of the river; only in the eaft corner of it the light was rather faint, and the fquare figure lefs perfect, as if it was cut off or darkened by the fegment of a circle.

His curiofity tempting him to examine this appearance a little nearer, he advanced gently towards the place; but was furprifed to find that it changed gradually from a bright red, firft to a yellowifh, and then to a pale colour, in proportion as he drew nearer; and when he came to the place itfelf it quite vanifhed. Upon this he ftepped back, and not only faw it again, but found that the farther he went from it, the ftronger and brighter it grew. When he examined the place of this luminous appearance, he could not perceive the leaft fmell, or any other mark of fire.

This extraordinary account was confirmed to M. Beccari by another gentleman, who frequently travelled the fame road, and who affured him that he had feen the very fame light five or fix different times, in fpring and autumn, and that he had always obferved it

it to be of the very fame fhape, and in the fame place; and he once took particular notice of its coming out of a neighbouring place, and fettling itfelf in the figure above defcribed.

M. Beccari owns himfelf to be greatly at a lofs to account not only for this very remarkable appearance, but alfo for the *ignes fatui* in general. He only fays, that all perfons who ever faw any of thefe appearances, agree, that they caft a light quite different from that of fhining flies.

Dr Shaw defcribes an ignis fatuus, which he faw in the Holy Land, the circumftances of which are very remarkable. As he and his company were travelling by night, through the valleys of mount Ephraim, they were attended, more than an hour, by an ignis fatuus, which was fometimes globular, or in the form of the flame of a candle; and which would, immediately afterwards, fpread itfelf fo much as to involve the whole company in a pale inoffenfive light, and then contract itfelf again, and fuddenly difappear. But in lefs than a minute it would become vifible as before; or, running along from one place to another, with a fwift progreffive motion, would expand itfelf, at certain intervals, over more than two or three acres of the adjacent mountains. The atmofphere, from the beginning of the evening, had been remarkably thick and hazy, and the dew, as they felt it upon their bridles, was unufually clammy and unctuous. In the fame kind of weather, he fays, he has obferved thofe luminous appearances, which, at fea, fkip about the mafts and yards of fhips, and which the failors call *corpufanfe*, which is a corruption of the Spanifh *cuerpo fanto*.

Of the *celeftial* meteors, the moft common are thofe called *falling-ftars*, which are fo well known, that it is needlefs to defcribe them. They do not very often appear of a larger fize than the brighteft fixed ftars, tho' fometimes they equal Jupiter, or even Venus in apparent bulk, and are then exceedingly bright. They fometimes rife high in the air; for Mr Brydone takes notice of his having feen them as high to appearance above the top of Mount Ætna, as they ufually appear when viewed from the ordinary ground. Sometimes, however, they are much lower. Signior Beccari mentions one which feemed to direct its courfe towards the place where he fat, growing continually larger and larger as it advanced, till at laft it difappeared at no great diftance, and left the faces, hands, and clothes, of thofe who faw it, and all the neighbouring objects, fuddenly illuminated with a diffufed and lambent light attended with no noife at all. While they were ftarting up, ftanding and looking at one another, furprifed at the appearance, a fervant came running to them out of a neighbouring garden, and afked them if they had feen nothing; for that he had feen a light fhine fuddenly in the garden, and efpecially upon the ftreams which he was throwing to water it.

The other kinds of celeftial meteors are, aurora borealis, lightning of various forms, and large fire-balls. All thefe too fometimes appear very high, and fometimes very low; the fire-balls efpecially, will fometimes ftrike the ground, and explode with great violence, producing many mifchievous effects. See Atmosphere, Aurora Borealis, Cloud, Lightning, &c.

The general principles on which the phenomena of meteors depend, have already been fo fully explained under the article Electricity, &c. that very little remains to be added in this place. The inoffenfive lights, fuch as appear on the points of metallic bodies, the ignis fatuus, &c. are occafioned by a current of electric matter fetting into or out of any particular body; for wherever that fluid is much agitated, there a light will be vifible. If at the fame time there is a confiderable difference between the electricity of the atmofphere and the furface of the ground, the electric ftream will be quietly imbibed, and no dangerous confequences will enfue to thofe who approach it; but if the electricity of the atmofphere and the ground happens to be much the fame, the fluid will then be much compreffed, will burn, explode, and produce all the mifchief of the forked or crooked lightning, or of that kind which appears in the form of balls, and which is fully explained under the article Lightning.

METHOD, the arrangement of our ideas in fuch a regular order, that their mutual connection and dependence may be readily comprehended. See Logic, n° 114.—118.

METHODISTS, a name at firft given to a fociety of religious young men at Oxford, and now applied to all thofe who adhere to the doctrine of the church of England as taught by Whitefield, Wefley, &c. They are faid to be, in general, plain well-meaning people, who do not diffent from the eftablifhed church, but profefs to live with great purity according to her articles. At their firft appearance their teachers were charged, in the heat of their zeal, with feveral irregularities, and many expreffions in their preaching which were not altogether unexceptionable: but as the civil government, with a moderation and wifdom peculiar to the prefent time, thought fit to overlook their behaviour, they have fince honeftly acknowledged wherein they were miftaken; and, in confequence of the perfect liberty of confcience they enjoy, have fubfided into a more regular and peaceable conduct, agreeable to the genuine fpirit of Chriftianity.

Methodists, *Methodici*, is alfo an appellation given to a fect of ancient phyficians, who reduced the whole healing art to a few common principles or appearances.

METHODIUS, a father of the church, bifhop of Olympus or Patara in Lycia, and afterward of Tyre in Paleftine, fuffered martyrdom at Chalcis in Greece toward the end of Dioclefian's perfecution in the year 302. He compofed many works in a clear and elaborate ftile, which were extant in Jerome's time. Father Combefis collected feveral confiderable fragments of this writer, cited by Epiphanius, Photius, and others; and printed them with notes of his own, together with the works of Amphilochius, and Andreas Cretenfis, in folio, Paris 1644.

METIUS (James), of Alcmaer, in Holland, the inventor of telefcopes with glaffes, one of which he prefented to the States General in 1609. Tubes extended, by uniting them, to a great length, were known to the ancients; but Metius was the firft who added glaffes, and he was indebted to chance for the difcovery: he had frequently obferved fome fchool-boys playing upon the ice, who made ufe of their co-

py-

py books rolled up in the ſhape of tubes, to look at each other, to which they ſometimes added pieces of ice at each end, to view diſtant objects: this led him to the invention of optic glaſſes.

METO, a famous mathematician of Athens, 432 B. C. publiſhed his *Anneadecatoride*, that is, his Cycle of Nineteen years, by which he endeavoured to adjuſt the courſe of the ſun to that of the moon, and to make the ſolar and lunar years begin at the ſame point of time. See Cycle *of the Moon*.

METONYMY, in rhetoric, is a trope in which one name is put for another, on account of the near relation there is between them. See Oratory, n° 51.

METOPE, in architecture, is the interval, or ſquare ſpace between the triglyphs of the Doric freeze, which among the ancients uſed to be painted or adorned with carved work, repreſenting the heads of oxen, or utenſils uſed in ſacrifices.

METOPOSCOPY, the pretended art of knowing a perſon's diſpoſitions and manners, by viewing the traces and lines in the face. Ciro Spontoni, who has wrote expreſsly on metopoſcopy, ſays, that ſeven lines are examined in the forehead, and that each line is conſidered as having its particular planet: the firſt is the line of Saturn, the ſecond of Jupiter, the third of Mars, &c. Metopoſcopy is only a branch of phyſiognomy, which founds its conjectures on all the parts of the body.

METRE, μετρικ, in poetry, a ſyſtem of feet of a juſt length.

The different metres in poetry, are the different manners of ordering and combining the quantities, or the long and ſhort ſyllables: thus hexameter, pentameter, iambic, ſapphic verſes, &c. conſiſt of different metres, or meaſures. See Hexameter.

In Engliſh verſes, the metres are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleaſes. The moſt uſual are the heroic, generally conſiſting of five long and five ſhort ſyllables, and verſes of four feet, and of three feet, and a cæſura, or ſingle ſyllable.

The ancients, by variouſly combining and tranſpoſing their quantities, made a vaſt variety of different meaſures, by forming ſpondees, &c. of different feet. See Poetry, n° 124, &c.

METRODORUS, a Greek phyſician, born at Chios, was the diſciple of Democritus the philoſopher, and the maſter of Hippocrates the phyſician and Anaxarchus the philoſopher. He maintained, that the univerſe is infinite and eternal: but his works are loſt. He lived about 444 B. C.

METROPOLIS, the capital or principal city of a country or province.

The term *metropolis* is alſo applied to archiepiſcopal churches, and ſometimes to the principal or mother-church of a city. The Roman empire having been divided into 13 dioceſes and 120 provinces, each dioceſe and each province had its metropolis, or capital city, where the proconſul had his reſidence. To this civil diviſion, the eccleſiaſtical was afterwards adapted, and the biſhop of the capital city had the direction of affairs, and the preheminence over all the biſhops of the province. His reſidence in the metropolis gave him the title of *metropolitan*. This erection of metropolitans is referred to the end of the third century, and was confirmed by the council of Nice. A metropolitan has the privilege of ordaining his ſuffragans; and appeals from ſentences paſſed by the ſuffragans are preferred to the metropolitan.

METZ, an ancient, large, and ſtrong town of France, and capital of the territory of Meſſin, with a citadel, a parliament, and a biſhop's ſee, whoſe biſhop aſſumes the title of a *prince of the empire*. The cathedral church is one of the fineſt in Europe, and the ſquare called *Coſlin*, and the houſe of the governor, are worth ſeeing. The Jews live in a part of the town by themſelves, where they have a ſynagogue. The ſweetmeats they make here are in high eſteem. It is ſeated at the confluence of the rivers Moſelle and Seille. E. Long. 6. 16. N. Lat. 49. 7.

MEURSIUS (John), a learned and laborious writer, born at Loſdun, near the Hague, in 1579. He early diſcovered a fondneſs for polite literature and the ſciences; and went to ſtudy the law at Orleans with the ſon of Barneveldt, whom he accompanied in his travels. In 1610 he was made profeſſor of hiſtory at Leyden, and afterwards Greek profeſſor. His reputation daily increaſing, Chriſtian IV. king of Denmark made him profeſſor of hiſtory and politics, in the univerſity of Sora. Meurſius filled that chair with univerſal applauſe; and died in 1641, aged 62. He wrote many learned works, ſeveral of which relate to the ancient ſtate of Greece; as, 1. *De populis Atticæ*. 2. *Atticarum lectionum libri* vi. 3. *Archontes Athenienſes*. 4. *Fortuna Attica*. 5. *De Athenarum origine*. 6. *De feſtis Græcorum*, &c. John Meurſius, his ſon, was alſo the author of ſeveral works. It ſeems almoſt needleſs to obſerve, that the ſcandalous obſcene Latin work, intitled *Meurſius*, is not either of our author or his ſon; but, as is ſaid, the notable production of one John Weſtranus, a lawyer at the Hague.

MEW, Sea-mew, or *Sea-mall*. See Anas.

Winter-Mew, or *Coddy-moddy*, in ornithology. See Larus.

MEWING, the falling off or change of hair, feathers, ſkin, horns, or other parts of animals, which happens in ſome annually, in others only at certain ſtages of their lives: but the generality of beaſts mew in the ſpring. An old hart caſts his horns ſooner than a young one, which is commonly in the months of February and March, after which they begin to button in March or April: and as the ſun grows ſtrong, and the ſeaſon of the year puts forth the fruits of the earth, ſo their heads grow, and are ſummed full by the middle of June. It is to be obſerved, that if a hart be gelt before he has a head, he will never have any; and if he be gelt after he has a head, he will never caſt his horns; again, if he be gelt when he has a velvet-head, it will always be ſo, without fraying, or burniſhing.

MEXICO, otherwiſe called *New-Spain*; a large country of America, bounded on the north by New-Mexico, on the eaſt by the gulf of Mexico and the North Sea, and on the ſouth and weſt by South America and the South Sea; extending upwards of 2000 miles in length, and from 60 to 600 in breadth.

1 Conqueſt of Mexico undertaken by Cortes.

This country was firſt diſcovered, though imperfectly, by a Spaniard named *Nunez de Balboa*; but, in 1518, the conqueſt of it was undertaken by a celebrated adventurer named *Ferdinando Cortes*. It was not, how-

however, without great difficulty that he got his expedition ſet on foot; being perſecuted by the Spaniſh governors in the Weſt Indies, ſo that he was at laſt obliged to throw off his allegiance to them, and proceed without any commiſſion. However, on the 10th of February 1519, he ſet ſail from the Havannah in Cuba; and ſoon landed on the iſland of Cozumel, on the coaſt of Yucatan, diſcovered the preceding year. Here he joined one of his officers named *Pedro d' Alvaredo*, who had arrived ſome days before, and collected ſome booty and taken a few priſoners. But the general ſeverely cenſured his conduct; and the priſoners were diſmiſſed, after they had been informed by an Indian interpreter named *Melchior*, that ſuch injuries were entirely diſagreeable to the intentions and wiſhes of Cortes. Here he muſtered his army, and found that it amounted to 508 ſoldiers, 16 horſemen, and 109 mechanics, pilots, and mariners. Having encouraged his men by a proper ſpeech, and releaſed, by means of ſome Indian ambaſſadors, a Spaniard named *Jerom de Aguilar*, who had been detained a priſoner for eight years, he proceeded to the river Tabaſco, where he hoped to be received in a friendly manner, as one Grijalva had been a ſhort time before; but, from ſome unknown cauſe, he was violently attacked by them: however, the ſuperiority of the Spaniſh arms ſoon decided the victory, and the inhabitants were obliged to own the king of Caſtile as their ſovereign.

2
Receives an embaſſy from the emperor of Mexico.

The Spaniards then continued their courſe weſtward, to the harbour of St Juan de Ullua; where they were met by two Mexican canoes, who carried two ambaſſadors from the emperor of that country, and ſhewed the greateſt ſigns of peace and amity. Their language was unknown to Aguilar; but one of the female ſlaves above-mentioned underſtood it, and tranſlated it into the Yucatan tongue; after which Aguilar interpreted the meaning in Spaniſh. This ſlave was afterwards named *Donna Marina*, and proved very uſeful in their conferences with the natives.

3
State of the empire at that time.

At this time the Mexican empire, according to Dr Robertſon, was arrived at a pitch of grandeur to which no ſociety had ever attained in ſo ſhort a period. Though it had ſubſiſted only for 130 years, its dominion extended from the north to ſouth ſea; over territories ſtretching about 500 leagues from eaſt to weſt, and more than 200 from north to ſouth; comprehending provinces not inferior in fertility, population, and opulence, to any in the torrid zone. The reigning emperor was called Montezuma, or *Motezuma*, whoſe authority was very deſpotic, and his temper haughty and cruel. Though by nature he poſſeſſed a good deal of courage and reſolution; yet from the firſt moment that the Spaniards appeared on his coaſt, he diſcovered ſymptoms of timidity and embarraſſment, and all his ſubjects were embarraſſed as well as himſelf. The general diſmay which took place on this occaſion was partly owing to the ſtrange figure the Spaniards made, and the prodigious power of their arms; but partly alſo to the following circumſtance. An opinion prevailed almoſt univerſally among the Americans, if we may believe the earlieſt and moſt authentic hiſtorians, that ſome dreadful calamity impended over their heads, from a race of formidable invaders who ſhould come from regions towards the riſing ſun, to over-run and deſolate their country. Whether this diſquieting apprehenſion flowed from the memory of ſome natural calamity which had afflicted that part of the globe, and impreſſed the minds of the inhabitants with ſuperſtitious fears and forebodings; or whether it was an imagination accidentally ſuggeſted by the aſtoniſhment which the firſt ſight of a race of new men occaſioned, it is impoſſible to determine. But as the Mexicans were more prone to ſuperſtition than any people in the new world, they were more deeply affected with the appearance of the Spaniards, whom they inſtantly ſuppoſed to be the inſtruments deſtined to bring about that fatal revolution which they dreaded: and this produced the embaſſy above-mentioned.

By means of his two interpreters, Donna Marina, and Aguilar, Cortes learned that the chiefs of the Mexican embaſſy were deputies from Pilpatoe and Teutile; the one governor of a province under the emperor, and the other the commander of all his forces in that province: the purport of their embaſſy was, to inquire what his intentions were in viſiting their coaſts, and to offer him what aſſiſtance he might need in order to continue his voyage. Cortes, in his turn, alſo profeſſed the greateſt friendſhip; and informed the ambaſſadors, that he came to propoſe matters of the utmoſt conſequence to the welfare of the prince and his kingdom; which he would more fully unfold in perſon to the governor and the general. Next morning, without waiting for any anſwer, he landed his troops, his horſes, and his artillery; began to erect huts for his men, and to fortify his camp. The natives, inſtead of oppoſing the entrance of theſe fatal gueſts into their country, aſſiſted them in all their operations, with an alacrity which they had ere long reaſon to repent.

4
Cortes lands and fortifies his camp.

The next day the ambaſſadors had a formal audience; at which Cortes acquainted them, that he came from Don Carlos of Auſtria, king of Caſtile, the greateſt monarch of the eaſt, and was intruſted with propoſitions of ſuch moment, that he would impart them to none but the emperor himſelf, and therefore required to be conducted immediately to the capital. This demand immediately produced the greateſt uneaſineſs; and the ambaſſadors did all in their power to diſſuade Cortes from his deſign, endeavouring to conciliate his good-will by the preſents ſent him by Montezuma. Theſe they introduced with great parade, and conſiſted of fine cotton-cloth, of plumes of various colours, and of ornaments of gold and ſilver to a conſiderable value, the workmanſhip of which appeared to be as curious as the materials were rich. But theſe preſents ſerved only to excite the avidity of the Spaniards, and to increaſe their deſire for becoming maſters of a country which abounded with ſo many precious commodities. Cortes indeed could ſcarcely reſtrain himſelf ſo far as to hear the arguments made uſe of by the ambaſſadors to diſſuade him from going to the capital; and, in a haughty, determined tone, inſiſted on his former demand of being admitted to a perſonal interview with their ſovereign.

5
The Indians endeavour to diſſuade him from going to the capital, but in vain.

During this converſation, ſome painters in the retinue of the Mexican chiefs had been diligently employed in delineating, upon white cotton cloths, figures of the ſhips, horſes, artillery, ſoldiers, and whatever elſe attracted their eyes as ſingular. When Cortes obſerved this, and was informed that theſe pictures were to be ſent to Montezuma, he reſolved to render the repreſentation ſtill more ſtriking and intereſting. The trumpets, by his orders, ſounded an alarm; the

Mexico. troops formed in order of battle, and ſhewed their agility and ſtrength in the beſt manner they could; while the artillery was pointed againſt the neighbouring trees, among which it made dreadful havock. The Indians for ſome time looked on with ſilent aſtoniſhment; but at the exploſion of the cannon, ſome fled, others fell to the ground, and all were ſo confounded, that Cortes found it difficult to quiet and compoſe their minds.

6 Montezuma made acquainted with his deſign.

When the painters had exerted their utmoſt efforts in repreſenting all theſe wonderful things, meſſengers were immediately diſpatched to Montezuma with the pictures, and a full account of every thing that had paſſed ſince the arrival of the Spaniards, together with ſome European curioſities to Montezuma; which, though of no great value, Cortes believed would be acceptable on account of their novelty. The Mexican monarchs, in order to obtain the earlieſt information of every occurrence in all parts of their empire, had couriers poſted at proper ſtations along the principal roads; and as theſe were trained to agility by a regular education, they conveyed intelligence with ſurpriſing rapidity. Though the city in which Montezuma reſided was above 180 miles from St Juan de Ullua, Cortes's preſents were carried thither, and an anſwer returned to his demands, in a few days.

7 Sends an unfavourable anſwer, but accompanied with rich preſents.

As the anſwer was unfavourable, Montezuma had endeavoured to mollify the Spaniſh general by the richneſs of his preſents. Theſe conſiſted of the manufactures of the country; cotton-ſtuffs ſo fine, and of ſuch delicate texture, as to reſemble ſilk; pictures of animals, trees, and other natural objects, formed with feathers of different colours, diſpoſed and mingled with ſuch ſkill and elegance as to rival the works of the pencil in truth and beauty of imitation. But what chiefly attracted their attention, were two large plates of a circular form; one of maſſive gold repreſenting the ſun, the other of ſilver repreſenting the moon. Theſe were accompanied with bracelets, collars, rings, and other trinkets of gold; and that nothing might be wanting which could give the Spaniards a complete idea of what the country afforded, ſome boxes filled with pearls, precious ſtones, and grains of gold unwrought, as they had been found in the mines or rivers, were ſent along with the reſt. Cortes received all with an appearance of the moſt profound reſpect for Montezuma; but when the Mexicans, preſuming upon this, informed him, that their maſter, though he deſired him to accept of what he had ſent as a token of his regard for the prince whom he repreſented, would not give his conſent that foreign troops ſhould approach nearer to his capital, or even allow them to continue longer in his dominions.

8 Cortes ſtill inſiſts on his demand.

Cortes declared, in a manner more reſolute and peremptory than formerly, that he muſt inſiſt on his firſt demand; as he could not, without diſhonour, return to his own ſovereign until he was admitted into the preſence of the prince whom he was appointed to viſit in his name. The Mexicans were aſtoniſhed at the ſight of a man who dared to oppoſe the will of their emperor; but not being willing to come to an open rupture with ſuch formidable enemies, with much ado they prevailed upon Cortes to promiſe that he would not move from his preſent camp until the return of a meſſenger whom they ſent to Montezuma for further inſtructions.

The puſillanimity of the Indian monarch afforded time to the Spaniards to take meaſures which would have been out of their power had they been vigorouſly attacked on their firſt refuſal to obey his orders. Cortes uſed every method of ſecuring the affections of the ſoldiers; which indeed was very neceſſary, as many of them began to exclaim againſt the raſhneſs of his attempt in leading them againſt the whole force of the Mexican empire.

9 Montezuma peremptorily commands him to leave his dominions.

In a ſhort time Teutile arrived with another preſent from Montezuma, and together with it delivered the ultimate orders of that monarch to depart inſtantly out of his dominions; and when Cortes, inſtead of complying with his demands, renewed his requeſt of audience, the Mexican immediately left the camp with ſtrong marks of ſurpriſe and reſentment. Next morning, none of the natives appeared; all friendly correſpondence ſeemed to be at an end, and hoſtilities were expected to commence every moment. A ſudden conſternation enſued among the Spaniards, and a party was formed againſt him by the adherents of Velaſques; who took advantage of the occaſion, and deputed one of their number, a principal officer, to remonſtrate, as if in name of the whole army, againſt his raſhneſs, and to urge the neceſſity of his returning to Cuba. Cortes received the meſſage without any appearance of emotion; and as he well knew the temper and wiſhes of his ſoldiery, and foreſaw how they would receive a propoſition ſo fatal to all the ſplendid hopes and ſchemes which they had been forming with ſuch complacency, he pretended to comply with the requeſt now made him, and iſſued orders that the army ſhould be in readineſs next day to embark for Cuba. Upon hearing this, the troops, as Cortes had expected, were quite outrageous: they poſitively refuſed to comply with theſe orders, and threatened immediately to chooſe another general if Cortes continued to inſiſt on their departure.

Our adventurer was highly pleaſed with the diſpoſition which now appeared among his troops: nevertheleſs, diſſembling his ſentiments, he declared, that his orders for embarking had proceeded from a perſuaſion that it was agreeable to his fellow-ſoldiers, to whoſe opinion he had ſacrificed his own; but now he acknowledged his error, and was ready to reſume his original plan of operation. This ſpeech was highly applauded; and Cortes, without allowing his men time to cool, ſet about carrying his deſigns into execution.

10 Villa Rica founded.

In order to give a beginning to a colony, he aſſembled the principal perſons in his army, and by their ſuffrages elected a council and magiſtrates, in whom the government was to be veſted. The perſons choſen were moſt firmly attached to Cortes; and the new ſettlement had the name of *Villa Rica de la vera Cruz*; that is, the rich town of the true croſs.

11 The government of the new colony veſted in Cortes.

Before this court of his own making, Cortes did not heſitate at reſigning all his authority, and was immediately re-elected chief-juſtice of the colony, and captain-general of its army, with an ample commiſſion, in the king's name, to continue in force till the royal pleaſure ſhould be farther known. The ſoldiers eagerly ratified their choice by loud acclamations; and Cortes, now conſidering himſelf as no longer accountable to any ſubject, began to aſſume a much greater degree of dignity, and to exerciſe more extenſive powers, than he had done before. Some of the ſoldiers began to exclaim againſt the proceedings of the council as illegal; but the ringleaders were in-

 ſtantly

Mexico. ſtantly ſent on board the fleet loaded with irons. By this timely ſeverity the reſt were overawed; and Cortes, knowing of how great importance unanimity was to his future ſucceſs, ſoon found means to reconcile thoſe who were moſt diſaffected; to which purpoſe a liberal diſtribution of the Mexican gold, both among friends and foes, contributed not a little.

11
Makes an alliance with the Cacique of Zempoalla.

Cortes, having thus ſtrengthened himſelf as well as he could, reſolved to advance into the country; and to this he was encouraged by the behaviour of the cacique or petty prince of Zempoalla, a conſiderable town at no great diſtance. This prince, though ſubject to Montezuma, was exceedingly impatient of the yoke; and ſo filled with dread and hatred of the emperor, that nothing could be more acceptable to him than an appearance of being delivered from that ſubjection; and a deliverance of this kind he now hoped from the Spaniards. For this reaſon he ſent ambaſſadors to Cortes, with offers of friendſhip, which were gladly accepted by him; and in conſequence of the alliance, he very ſoon viſited Zempoalla. Here he was received in the moſt friendly manner imaginable, and had a reſpect paid towards him almoſt equivalent to adoration. The cacique informed him of many particulars relating to the character of Montezuma.—He told him, that he was a tyrant, haughty, cruel, and ſuſpicious; who treated his own ſubjects with arrogance, ruined the conquered provinces by his extortions, and often tore their ſons and daughters from them by violence; the former to be offered as victims to his gods, the latter to be reſerved as concubines for himſelf and favourites. Cortes, in reply, artfully inſinuated, that one great object of the Spaniards in viſiting a country ſo remote from their own was, to redreſs grievances, and to relieve the oppreſſed; and having encouraged him to hope for this interpoſition in due time, continued his march to Quiabiſlan, the territory of another cacique, and where, by the friendly aid of the Indians, a Spaniſh colony was ſoon formed.

12
Character of Montezuma given by the cacique.

During the reſidence of Cortes in theſe parts, he ſo far wrought on the minds of the caciques of Zempoalla and Quiabiſlan, that they ventured to inſult the Mexican power, at the very name of which they had been formerly accuſtomed to tremble. Some of Montezuma's officers having appeared to levy the uſual tribute, and to demand a certain number of human victims, as an expiation of their guilt in preſuming to hold intercourſe with thoſe ſtrangers whom the emperor had commanded to leave his dominions; inſtead of obeying his orders, they made them priſoners, treated them with great indignity, and, as their ſuperſtition was no leſs barbarous than Montezuma's, they threatened to ſacrifice them to their gods. From this laſt danger, however, they were delivered by the interpoſition of Cortes, who manifeſted the utmoſt horror at the mention of ſuch a deed. This act of rebellion firmly attached the two caciques to the intereſt of Cortes; and without heſitation they acknowledged themſelves vaſſals of the king of Spain. Their example was followed by the Totonaques, a fierce people who inhabited the mountainous parts of the country. They willingly ſubjected themſelves to the crown of Caſtile; and offered to accompany Cortes with all their forces in his march towards Mexico.

13
The caciques of Zempoalla, Quiabiſlan, and ſome others, ſubmit.

Though Cortes had now taken ſuch meaſures as in a manner enſured his ſucceſs; yet, as he had thrown off all dependence on the governor of Cuba, who was his lawful ſuperior, and apprehended his intereſt at court, he thought proper, before he ſet out on his intended expedition, to take the moſt effectual meaſures againſt the impending danger. With this view, he perſuaded the magiſtrates of his colony to addreſs a letter to the king, containing a pompous account of their own ſervices, of the country they had diſcovered, &c. and of the motives which had induced them to throw off their allegiance to the governor of Cuba, and to ſettle a colony dependent on the crown alone, in which the ſupreme power civil as well as military had been veſted in Cortes; humbly requeſting their ſovereign to ratify what had been done by his royal authority. Cortes himſelf wrote in a ſimilar ſtrain; but as he knew that the Spaniſh court, accuſtomed to the repeated exaggerations of American adventurers, would give little credit to the ſplendid accounts of New-Spain, if they were not accompanied with ſuch a ſpecimen of what it contained as would excite an high idea of its opulence, he ſolicited his ſoldiers to relinquiſh what they might claim as their part of the treaſures which had hitherto been collected, in order that the whole might be ſent to the king. Portocarrero and Montejo, the chief magiſtrates of the colony, were appointed to carry this preſent to Caſtile, with expreſs orders not to touch at Cuba in their paſſage thither. But while a veſſel was preparing for their departure, an unexpected event produced a general alarm. Some ſoldiers and ſailors, ſecretly diſaffected to Cortes, formed a deſign of ſeizing one of the brigantines, and making their eſcape to Cuba, in order to give ſuch intelligence to the governor, as might enable him to intercept the veſſel which was to carry the treaſure and diſpatches to Spain. This conſpiracy was conducted with profound ſecreſy; but at the moment when every thing was ready for execution, the ſecret was diſcovered by one of the aſſociates. The latent ſpirit of diſaffection which Cortes was now too well convinced had not been extinguiſhed amongſt his troops, gave him very great uneaſineſs. The only method which he could think of to prevent ſuch conſpiracies for the future was, to deſtroy his fleet; and thus deprive his ſoldiers of every reſource except that of conqueſt: and with this propoſal he perſuaded his men to comply. With univerſal conſent therefore the ſhips were drawn aſhore, and, after being ſtripped of their ſails, rigging, iron-work, and whatever elſe might be of uſe, they were broke in pieces.

14
The magiſtrates of Villa Rica ſend a letter to the king of Spain in favour of Cortes.

15
Cortes burns his fleet.

Cortes having thus rendered it neceſſary for his troops to follow wherever he choſe to lead, began his march from Zempoalla with 500 infantry, 15 horſe, and ſix field-pieces. The reſt of his troops, conſiſting chiefly of ſuch as from age or infirmity were leſs fit for active ſervice, he left as a garriſon in Villa Rica, under the command of Eſcalante, an officer of merit, and warmly attached to his intereſt. The cacique of Zempoalla ſupplied him with proviſions; and with 200 of thoſe Indians called *Tamames*, whoſe office, in a country where tame animals were unknown, was to carry

Mexico. carry burdens, and perform all manner of servile labour. He offered likewise a considerable body of troops; but Cortes was satisfied with 400; taking care, however, to choose persons of such note, that they might serve as hostages for the fidelity of their master.

Nothing memorable happened till the Spaniards arrived on the confines of the republic of Tlascala. The inhabitants of that province were warlike, fierce, and revengeful, and had made considerable progress in agriculture and some other arts. They were implacable enemies to Montezuma; and therefore Cortes hoped that it would be an easy matter for him to procure their friendship. With this view, four Zempoallans of high rank were sent ambassadors to Tlascala, dressed with all the badges of that office usual among the Indians. The senate were divided in their opinions with regard to the proposals of Cortes: but at last, Magiscatzin, one of the oldest senators, and a person of great authority, mentioned the tradition of their ancestors, and the revelations of their priests; that a race of invincible men, of divine origin, who had power over the elements, should come from the east to subdue their country. He compared the resemblance which the strangers bore to the persons figured in the tradition of Mexico, their dominion over the elements of fire, air, and water; he reminded the senate of their prodigies, omens, and signals, which had lately terrified the Mexicans, and indicated some very important event; and then declared his opinion, that it would be rashness to oppose a force apparently assisted by heaven, and men who had already proved, to the sad experience of those who opposed them, that they were invincible. This orator was opposed by Xicotencal, who endeavoured to prove that the Spaniards were at best but powerful magicians; that they had rendered themselves obnoxious to the gods by pulling down their images and altars, (which indeed Cortes had very imprudently done at Zempoalla); and of consequence, that they might easily be overcome, as the gods would not fail to resent such an outrage. He therefore voted for war, and advised the crushing of these invaders at one blow.

16 Sends ambassadors to the republic of Tlascala.

17 The Tlascalans resolve on war.

The advice of Xicotencal prevailed; and in consequence of it, the ambassadors were detained; which giving Cortes the alarm, he drew nearer the city of Tlascala. In this transaction we may easily see how little the Tlascalans, notwithstanding all their ferocity, were skilled in military affairs. They suffered Cortes, with his army drawn up in good order, to pass a strong wall between two mountains, which might have been very advantageously defended against him. He had not advanced far beyond this pass, however, before a party of Tlascalans with plumes were discovered, which denoted that an army was in the field. These he drove before him by a detachment of six horse, obliged them to join another party, and then reinforcing the advanced detachment, charged the enemy with such vigour that they began to retire. Five thousand Tlascalans, whom Xicotencal had placed in ambush, then rushed out of their hiding places, just as the infantry came up to assist their slender body of cavalry. The enemy attacked with the utmost fury; but were so much disconcerted by the first discharge of the fire-arms, that they retreated in confusion, furnishing the Spaniards with an opportunity of pursuing them with great slaughter. Cortes, however, supposing that this could not be their whole force, advanced with the utmost caution, in order of battle, to an eminence, from whence he had a view of the main body of the Tlascalan army commanded by Xicotencal, consisting of no fewer than 40,000 men. By these the small army of Cortes was entirely surrounded; which Xicotencal no sooner perceived, than he contracted the circle with incredible diligence, while the Spaniards were almost overwhelmed with showers of arrows, darts, and stones. It is impossible but in this case many of the Spaniards must have perished, had it not been for the insufficiency of the Indian weapons. Their arrows and spears were headed only with flint, or the bones of fishes; their stakes hardened in the fire, and wooden swords, though destructive weapons among naked Indians, were easily turned aside by the Spanish bucklers, and could hardly penetrate the quilted jackets which the soldiers wore. These circumstances gave the Spaniards a prodigious advantage over them; and therefore, the Tlascalans notwithstanding their valour and superiority in number, could accomplish no more in the present instance, than to kill one horse, and slightly wound nine soldiers.

The Tlascalans being taught by this, and some subsequent encounters, how much they were inferior to the Spaniards, began to conceive them to be really what Magiscatzin had said; a superior order of beings, against whom human power could not prevail. In this extremity they had recourse to their priests, requiring them to reveal the causes of such extraordinary events, and to declare what means they should take to repel such formidable invaders. The priests, after many sacrifices and incantations, delivered their response, That these strangers were the offspring of the sun, procreated by his animating energy in the regions of the east: that, by day, while cherished with the influence of his parental beams, they were invincible; but by night, when his reviving heat was withdrawn, their vigour declined and faded like herbs in the field, and they dwindled down into mortal men. In consequence of this, the Tlascalans acted in contradiction to one of their most established maxims in war, and ventured to attack the enemy in the night-time, hoping to destroy them when enfeebled and surprised. But the Spanish centinels having observed some extraordinary movements among the Tlascalans, gave the alarm. Immediately the troops were under arms, and sallying out, 18
defeated their antagonists with great slaughter, without allowing them to approach the camp. By this disaster the Tlascalans were heartily disposed to peace; but they were at a loss to form an adequate idea of the enemies they had to deal with. They could not ascertain the nature of these surprising beings, or whether they were really of a benevolent or malignant disposition. There were circumstances in their behaviour which seemed to favour each opinion. On the one hand, as the Spaniards constantly dismissed the prisoners whom they took, not only without injury, but often with presents of European toys, and renewed their offers of peace after every victory; this lenity amazed people accustomed to the exterminating system of war known in America, and who sacrificed and devoured without mercy all the captives taken in battle; and

But are defeated and sue for peace.

and disposed them to entertain sentiments favourable to their humanity. But, on the other hand, as Cortes had seized 50 of their countrymen who brought provisions to their camp, and cut off their heads; this bloody spectacle, added to the terror occasioned by the fire-arms and horses, filled them with dreadful ideas of their ferocity. Accordingly they addressed them in the following manner: "If, (said they), you are divinities of a cruel and savage nature, we present to you five slaves, that you may drink their blood and eat their flesh. If you are mild deities, accept an offering of incense and variegated plumes. If you are men, here is meat, bread, and fruit, to nourish you."

19
Which is granted.

After this address, the peace was soon concluded, to the great satisfaction of both parties. The Tlascalans yielded themselves as vassals to the crown of Castile, and engaged to assist Cortes in all his operations; while he took the republic under his protection, and promised to defend their persons and possessions from injury and violence.

20
Great distresses of the Spaniards.

This reconciliation took place at a very seasonable juncture for the Spaniards. They were not only worn out with incessant toil, but so destitute of necessaries, that they had no other salve to dress their wounds but what was composed of the fat of Indians whom they had slain. Their distresses, in short, were arisen to such an height that they had begun to murmur, and even to despair, insomuch that Cortes had much difficulty in restraining them within any kind of bounds: but the submission of the Tlascalans, and their own triumphant entry into the city, where they were received with the reverence due to a superior order of beings, banished at once all memory of past sufferings, dispelled every anxious thought, and fully convinced them that they could not be resisted by any power in America.

Cortes left no method untried to gain the favour and confidence of the Tlascalans; which, however, he had almost entirely lost, by his untimely zeal in destroying their idols as he had done those of Zempoalla. But he was deterred from this rash action by his chaplain, father Bartholomew de Olmedo; and left the Tlascalans in the undisturbed exercise of their superstition, requiring only that they should desist from their horrid practice of offering human victims.

21
Cortes continues his march for Mexico.

As soon as his troops were fit for service, he resolved to continue his march towards Mexico, notwithstanding the remonstrances of the Tlascalans, who looked upon his destruction as unavoidable if he put himself into the power of such a faithless prince as Montezuma. But the emperor, probably intimidated with the fame of his exploits, had resolved to admit his visit; and informed Cortes that he had given orders for his friendly reception at Cholula, the next place of any consequence on the road to Mexico.

22
Treachery of Montezuma and the Cholulans.

In this, however, he was by no means sincere. Cholula was looked upon by all the inhabitants of the empire as a very holy place; the sanctuary and chief seat of their gods, to which pilgrims resorted from every province, and a greater number of human victims were offered in its principal temple than even in that of Mexico. Montezuma therefore invited the Spaniards thither, either from some superstitious hope that the gods would not suffer this sacred mansion to be defiled; or from a belief, that he himself might there find an opportunity of cutting them off with more certainty of success, when under the immediate protection of his gods. Cortes, however, was received with much seeming cordiality; but 6000 Tlascalan troops who accompanied him were obliged to remain without the town, as the Cholulans refused to admit their ancient enemies within their precincts. Yet two of these, by disguising themselves, got into the city, and acquainted Cortes that they observed the women and children belonging to the principal citizens retiring every night in a great hurry, and that six children had been sacrificed in the great temple; a sign that some warlike enterprise was at hand. At the same time Donna Marina, the interpreter, received information from an Indian woman of distinction, whose confidence she had gained, that the destruction of the Spaniards was concerted; that a body of Mexican troops lay concealed near the town; that some of the streets were barricaded, in others deep pits or trenches were dug, and slightly covered over, as traps into which the horse might fall; that stones and missive weapons were collected on the tops of the temples, with which to overwhelm the infantry; that the fatal hour was already at hand, and their ruin unavoidable.

23
Severe punishment of the Cholulans.

Cortes, alarmed at this news, secretly arrested three of the chief priests, from whom he extorted a confession that confirmed the intelligence he had already received. As not a moment was to be lost, he instantly resolved to prevent his enemies, and to inflict on them such dreadful vengeance as might strike Montezuma and his subjects with terror. For this purpose the Spaniards and Zempoallans were drawn up in a large court, which had been allotted for their quarters, near the centre of the town; the Tlascalans had orders to advance; the magistrates and chief citizens were sent for under various pretexts, and seized. On a signal given, the troops rushed out, and fell upon the multitude, destitute of leaders, and so much astonished, that the weapons dropped from their hands, and they stood motionless, and incapable of defence. While the Spaniards attacked them in front, the Tlascalans did the same in the rear; the streets were filled with slaughter; the temples, which afforded a retreat to the priests and some leading men, were set on fire, and they perished in the flames. This scene of horror continued two days; during which the wretched inhabitants suffered all that the destructive rage of the Spaniards, or the implacable revenge of their Indian allies, could inflict. At length the carnage ceased, after the slaughter of 6000 Cholulans, without the loss of a single Spaniard. Cortes then released the magistrates; and reproaching them bitterly for their intended treachery, declared, that as justice was now appeased, he forgave the offence; but required them to recall the inhabitants who had fled, and re-establish order in the town. Such was the ascendant that the Spaniards had now obtained over this superstitious race, that this order was instantly complied with; and the city was in a few days again filled with people, who paid the most respectful service to those men whose hands were stained with the blood of their relations and fellow-citizens.

24
Disaffection of Montezuma's subjects.

From Cholula, Cortes advanced directly towards Mexico; and throughout the whole of his journey was entertained with accounts of the oppressions and cruelty of Montezuma. This gave him the greatest hope of accomplishing his design; as he now perceived that the

Mexico. the empire was entirely divided, and no ſort of unanimity prevailed among them. No enemy appeared to check his progreſs. Montezuma was quite irreſolute; and Cortes was almoſt at the gates of the capital, before the emperor had determined whether to receive him as a friend, or oppoſe him as an enemy. But as no ſign of open hoſtility appeared, the Spaniards, without regarding the fluctuations of Montezuma's ſentiments, continued their march to Mexico, with great circumſpection and the ſtricteſt diſcipline, though without ſeeming to ſuſpect the prince whom they were about to viſit.

25 Meeting of Cortes and Montezuma.

When they drew near the city, about 1000 perſons, who appeared to be of diſtinction, came forth to meet them, adorned with plumes, and clad in mantles of fine cotton. Each of theſe, in his order, paſſed by Cortes, and ſaluted him according to the mode deemed moſt reſpectful and ſubmiſſive in their country. They announced the approach of Montezuma himſelf, and ſoon after his harbingers came in ſight. There appeared firſt 200 perſons in an uniform dreſs, with large plumes of feathers, alike in faſhion, marching two and two, in deep ſilence, barefooted, with their eyes fixed on the ground. Theſe were followed by a company of higher rank, in their moſt ſhowy apparel; in the midſt of whom was Montezuma, in a chair or litter richly ornamented with gold, and feathers of various colours. Four of his principal favourites carried him on their ſhoulders, others ſupported a canopy of curious workmanſhip over his head. Before him marched three officers with rods of gold in their hands, which they lifted up on high at certain intervals; and at that ſignal all the people bowed their heads, and hid their faces, as unworthy to look on ſo great a monarch. When he drew near, Cortes diſmounted, advancing towards him with officious haſte, and in a reſpectful poſture. At the ſame time Montezuma alighted from his chair, and leaning on the arms of two of his near relations, approached with a ſlow and ſtately pace, his attendants covering the ſtreet with cotton cloths, that he might not touch the ground. Cortes accoſted him with profound reverence, after the European faſhion. He returned the ſalutation, according to the mode of his country, by touching the earth with his hand, and then kiſſing it. This ceremony, the cuſtomary expreſſion of reverence from inferiors towards thoſe who are above them in rank, appeared ſuch amazing condeſcenſion in a proud monarch, who ſcarcely deigned to conſider the reſt of mankind as of the ſame ſpecies with himſelf, that all his ſubjects firmly believed thoſe perſons, before whom he humbled himſelf in this manner, to be ſomething more than human. Accordingly, as they marched through the crowd, the Spaniards frequently, and with much ſatisfaction, heard themſelves denominated *teules*, or *divinities*. Nothing material paſſed in this firſt interview. Montezuma conducted Cortes to the quarters which he had prepared for his reception; and immediately took leave of him, with a politeneſs not unworthy of a court more refined. "You are now, (ſays he), with your brothers, in your own houſe; refreſh yourſelves after your fatigue, and be happy until I return." The place allotted to the Spaniards for their lodging was a houſe built by the father of Montezuma. It was ſurrounded by a ſtone-wall, with towers at proper diſtances, which ſerved for defence as well as for ornament; and its apartments and courts were ſo large as to accommodate both the Spaniards and their Indian allies. The firſt care of Cortes was to take precautions for his ſecurity, by planting the artillery ſo as to command the different avenues which led to it, by appointing a large diviſion of his troops to be always on guard, and by poſting centinels at proper ſtations, with injunctions to obſerve the ſame vigilant diſcipline as if they were within ſight of an enemy's camp.

In the evening Montezuma returned to viſit his gueſts with the ſame pomp as in their firſt interview; and brought preſents of ſuch value, not only to Cortes and to his officers, but even to the private men, as proved the liberality of the monarch to be ſuitable to the opulence of his kingdom. A long conference enſued, in which Cortes learned what was the opinion of Montezuma with reſpect to the Spaniards. It was an eſtabliſhed tradition, he told him, among the Mexicans, that their anceſtors came originally from a remote region, and conquered the provinces now ſubject to his dominion; that after they were ſettled there, the great captain who conducted this colony returned to his own country, promiſing, that at ſome future period his deſcendants ſhould viſit them, aſſume the government, and reform their conſtitutions and laws; that, from what he had heard and ſeen of Cortes and his followers, he was convinced that they were the very perſons whoſe appearance and prophecies taught them to expect; that accordingly he had received them, not as ſtrangers, but as relations of the ſame blood and parentage, and deſired that they might conſider themſelves as maſters in his dominions; for both himſelf and his ſubjects ſhould be ready to comply with their will, and even to prevent their wiſhes. Cortes made a reply in his uſual ſtyle with reſpect to the dignity and power of his ſovereign, and his intention in ſending him into that country; artfully endeavouring ſo to frame his diſcourſe, that it might coincide as much as poſſible with the idea which Montezuma had formed concerning the origin of the Spaniards. Next morning, Cortes and ſome of his principal attendants were admitted to a public audience of the emperor. The three ſubſequent days were employed in viewing the city; the appearance of which, ſo far ſuperior in the order of its buildings and the number of its inhabitants to any place the Spaniards had beheld in America, and yet ſo little reſembling the ſtructure of an European city, filled them with ſurpriſe and admiration.

26 Deſcription of the city of Mexico.

Mexico, *Tenuchtitlan*, as it was anciently called by the natives, is ſituated in a large plain, environed by mountains of ſuch height, that though within the torrid zone, the temperature of its climate is mild and healthful. All the moiſture which deſcends from the high grounds is collected in ſeveral lakes, the two largeſt of which, of about 90 miles in circuit, communicate with each other. The waters of the one are freſh, thoſe of the others brackiſh. On the banks of the latter, and on ſome ſmall iſlands adjoining to them, the capital of Montezuma's empire was built. The acceſs to the city was by artificial cauſeways or ſtreets, formed of ſtones and earth, about 30 feet in breadth. As the waters of the lake, during the rainy ſeaſon, overflowed the flat country, theſe cauſeways were of con-

Mexico. considerable length. That of Tacuba on the weft a mile and a half; that of Tezeuco on the north-weft three miles; that of Cuoyacan towards the fouth fix miles. On the eaft there was no caufeway, and the city could be approached only by canoes. In each of thefe caufeways were openings, at proper intervals, through which the waters flowed; and over thefe beams of timber were laid, which being covered with earth, the caufeway or ftreet had every where an uniform appearance. As the approaches to the city were fingular, its conftruction was remarkable. Not only the temple of their gods, but the houfes belonging to the monarch and to perfons of diftinction, were of fuch dimenfions, that, in comparifon with any other buildings which had been difcovered in America, they might be termed *magnificent*. The habitations of the common people were mean, refembling the huts of other Indians. But they were all placed in a regular manner, on the banks of the canals which paffed thro' the city, in fome of its diftricts, or on the fides of the ftreets which interfected it in other quarters. In feveral places were large openings or fquares, one of which, allotted for the great market, is faid to have been fo fpacious, that 40,000 or 50,000 perfons carried on traffic there. In this city, the pride of the New World, and the nobleft monument of the induftry and art of man, while unacquainted with the ufe of iron, and deftitute of aid from any domeftic animal, the Spaniards, who are moft moderate in their computations, reckon that there were at leaft 60,000 inhabitants.

27 Uneafinefs of the Spaniards.

But how much foever the novelty of thofe objects might amufe or aftonifh the Spaniards, they felt the utmoft folicitude with refpect to their own fituation. From a concurrence of circumftances, no lefs unexpected than favourable to their progrefs, they had been allowed to penetrate into the heart of a powerful kingdom, and were now lodged in its capital, without having once met with open oppofition from its monarch. The Tlafcalans, however, had earneftly diffuaded them from placing fuch confidence in Montezuma as to enter a city of fuch a peculiar fituation as Mexico, where that prince would have them at mercy, fhut up as it were in a fnare, from which it was impoffible to efcape. They affured him that the Mexican priefts had, in the name of the gods, counfelled their fovereign to admit the ftrangers into the capital, that he might cut them off there at one blow with perfect fecurity. The Spaniards now perceived, too plainly, that the apprehenfions of their allies were not deftitute of foundation; that, by breaking the bridges placed at certain intervals on the caufeways, or by deftroying part of the caufeways themfelves, their retreat would be rendered impracticable; and they muft remain cooped up in the centre of a hoftile city, furrounded by multitudes fufficient to overwhelm them, and without a poffibility of receiving aid from their allies. Montezuma had, indeed, received them with diftinguifhed refpect. But ought they to reckon upon this as real, or to confider it as feigned? Even if it were fincere, could they promife on its continuance? Their fafety depended upon the will of a monarch in whofe attachment they had no reafon to confide; and an order flowing from his caprice, or a word uttered by him in paffion, might decide irrevocably concerning their fate.

Mexico. 28 Some hoftilities between the Spaniards and Mexicans.

Thefe reflections, fo obvious as to occur to the meaneft foldier, did not efcape the vigilant fagacity of their general. Before he fet out from Cholula, Cortes had received advice from Villa Rica, that Qualpopoca, one of the Mexican generals on the frontiers, having affembled an army in order to attack fome of the people whom the Spaniards had encouraged to throw off the Mexican yoke, Efcalante had marched out with part of the garrifon to fupport his allies; that an engagement had enfued, in which, though the Spaniards were victorious, Efcalante, with feven of his men, had been mortally wounded, his horfe killed, and one Spaniard had been furrounded by the enemy and taken alive; that the head of this unfortunate captive, after being carried in triumph to different cities, in order to convince the people that their invaders were not immortal, had been fent to Mexico. Cortes, though alarmed with this intelligence, as an indication of Montezuma's hoftile intentions, had continued his march. But as foon as he entered Mexico, he became fenfible, that, from an excefs of confidence in the fuperior valour and difcipline of his troops, as well as from the difadvantage of having nothing to guide him in an unknown country but the defective intelligence which he received from people with whom his mode of communication was very imperfect, he had pufhed forward into a fituation, where it was difficult to continue, and from which it was dangerous to retire. Difgrace, and perhaps ruin, was the certain confequence of attempting the latter. The fuccefs of his enterprife depended upon fupporting the high opinion which the people of New Spain had formed with refpect to the irrefiftible power of his arms. Upon the firft fymptom of timidity on his part, their veneration would ceafe, and Montezuma, whom fear alone reftrained at prefent, would let loofe upon him the whole force of his empire. At the fame time, he knew that the countenance of his own fovereign was to be obtained only by a feries of victories; and that nothing but the merit of extraordinary fuccefs could fcreen his conduct from the cenfure of irregularity. From all thefe confiderations, it was neceffary to maintain his ftation, and to extricate himfelf out of the difficulties in which one bold ftep had involved him, by venturing upon another ftill bolder. The fituation was trying, but his mind was equal to it; and after revolving the matter with deep attention, he fixed upon a plan no lefs extraordinary than daring. He determined to feize Montezuma in his palace, and carry him a prifoner to the Spanifh quarters. From the fuperftitious veneration of the Mexicans for the perfon of their monarch, as well as their implicit fubmiffion to his will, he hoped, by having Montezuma in his power, to acquire the fupreme direction of their affairs; or at leaft, with fuch a facred pledge in his hands, he made no doubt of being fecure from any effort of their violence.

29 Cortes refolves to feize Montezuma in his palace.

This he immediately propofed to his officers. The timid ftartled at a meafure fo audacious, and raifed objections. The more intelligent and refolute, confcious that it was the only refource in which there appeared any profpect of fafety, warmly approved of it, and brought over their companions fo cordially to the fame opinion, that it was agreed inftantly to make the attempt. At his ufual hour of vifiting Montezuma, Cortes went to the palace, accompanied by Alvarado, Saudoval,

Sandoval, Lugo, Velaſquez de Leon, and Davila, five of his principal officers, and as many truſty ſoldiers. Thirty choſen men followed, not in regular order, but ſauntering at ſome diſtance, as if they had no object but curioſity; ſmall parties were poſted at proper intervals, in all the ſtreets leading from the Spaniſh quarters to the court; and the remainder of his troops, with the Tlaſcalan allies, were under arms, ready to ſally out on the firſt alarm. Cortes and his attendants were admitted without ſuſpicion; the Mexicans retiring, as uſual, out of reſpect. He addreſſed the monarch in a tone very different from that which he had employed in former conferences; reproaching him bitterly as the author of the violent aſſault made upon the Spaniards by one of his officers, and demanded public reparation for the loſs which he had ſuſtained by the death of ſome of his companions, as well as for the inſult offered to the great prince whoſe ſervants they were. Montezuma, confounded at this unexpected accuſation, and changing colour either from the conſciouſneſs of guilt, or from feeling the indignity with which he was treated, aſſerted his own innocence with great earneſtneſs; and, as a proof of it, gave orders inſtantly to bring Qualpopoca and his accomplices priſoners to Mexico. Cortes replied, with ſeeming complaiſance, that a declaration ſo reſpectable left no doubt remaining in his own mind; but that ſomething more was requiſite to ſatisfy his followers, who would never be convinced that Montezuma did not harbour hoſtile intentions againſt them, unleſs, as an evidence of his confidence and attachment, he removed from his own palace and took up his reſidence in the Spaniſh quarters, where he ſhould be ſerved and honoured as became a great monarch. The firſt mention of ſo ſtrange a propoſal bereaved Montezuma of ſpeech, and almoſt of motion. At length he haughtily anſwered, "That perſons of his rank were not accuſtomed voluntarily to give up themſelves as priſoners; and were he mean enough to do ſo, his ſubjects would not permit ſuch an affront to be offered to their ſovereign." Cortes, unwilling to employ force, endeavoured alternately to ſoothe and intimidate him. The altercation became warm; and having continued above three hours, Velaſquez de Leon, an impetuous and gallant young man, exclaimed with impatience, "Why waſte more time in vain? Let us either ſeize him inſtantly, or ſtab him to the heart." The threatening voice and fierce geſtures with which theſe words were uttered, ſtruck Montezuma. The Spaniards, he was ſenſible, had now proceeded ſo far, as left him no hope that they would recede. His own danger was imminent, the neceſſity unavoidable. He ſaw both; and abandoning himſelf to his fate, complied with their requeſt.

30
The emperor carried to the Spaniſh quarters.

His officers were called. He communicated to them his reſolution. Though aſtoniſhed and afflicted, they preſumed not to queſtion the will of their maſter, but carried him in ſilent pomp, all bathed in tears, to the Spaniſh quarters. When it was known that the ſtrangers were conveying away the emperor, the people broke out into the wildeſt tranſports of grief and rage, threatening the Spaniards with immediate deſtruction, as the puniſhment juſtly due to their impious audacity. But as ſoon as Montezuma appeared with a ſeeming gaiety of countenance, and waved his hand, the tumult was huſhed; and upon his declaring it to be of his own choice that he went to reſide for ſome time among his new friends, the multitude, taught to revere every intimation of their ſovereign's pleaſure, quietly diſperſed.

The Spaniards at firſt pretended to treat Montezuma with great reſpect; but ſoon took care to let him know that he was entirely in their power. Cortes wiſhed that the ſhedding the blood of a Spaniard ſhould appear the moſt heinous crime that could be committed; and therefore not only took a moſt exemplary vengeance on thoſe who had been concerned in the affair of Villa Rica, but even put the emperor himſelf in chains till the execution of the Mexican general was over. By theſe, and other inſults, he at laſt gained entirely the aſcendant over this unhappy monarch; and he took care to improve his opportunity to the utmoſt. He ſent his emiſſaries into different parts of the kingdom, accompanied with Mexicans of diſtinction, who might ſerve both to guide and to protect them. They viſited moſt of the provinces, viewed their ſoil and productions, ſurveyed with particular care the diſtricts which yielded gold or ſilver, pitched upon ſeveral places as proper for future colonies, and endeavoured to prepare the minds of the people for ſubmitting to the Spaniſh yoke: and while they were thus employed, Cortes, in the name and by the authority of Montezuma, degraded ſome of the principal officers in the empire, whoſe abilities or independent ſpirit excited his jealouſy; and ſubſtituted in their place perſons who he imagined would be more obſequious. One thing, however, was ſtill wanting to complete his ſecurity. He wiſhed to have ſuch a command of the lake as might enſure a retreat, if, either from levity or diſguſt, the Mexicans ſhould take arms againſt him, and break down the bridges or cauſeways, in order to incloſe him in the city. In order to obtain this without giving diſguſt to the emperor or his court, Cortes artfully inflamed the curioſity of the Indians with accounts of the Spaniſh ſhipping, and thoſe floating palaces that moved with ſuch velocity on the water, without the aſſiſtance of oars; and when he found that the monarch himſelf was extremely deſirous of ſeeing ſuch a novelty, he gave him to underſtand, that nothing was wanting to his gratification beſides a few neceſſaries from Vera Cruz, for that he had workmen in his army capable of building ſuch veſſels. The bait took with Montezuma; and he gave immediate orders that all his people ſhould aſſiſt Cortes in whatever he ſhould direct concerning the ſhipping. By this means, in a few days, two brigantines were got ready, full-rigged and equipped; and Montezuma was invited on board, to make the firſt trial of their ſailing, of which he could form no idea. Accordingly he embarked for this purpoſe, and gave orders for a great hunting upon the water, in order that all his people might be diverted with the novelty preſented by the Spaniards. On the day appointed, the royal equipage was ready early in the morning; and the lake was covered with a multitude of boats and canoes loaded with people. The Mexicans had augmented the number of their rowers on board the royal barges, with an intention to diſgrace the Spaniſh veſſels, which they regarded as clumſy, unweildy, and heavy. But they were ſoon undeceived; a freſh gale ſtarted up, the brigantines hoiſted ſail, to the utter aſtoniſhment of all the ſpectators, and ſoon left all the canoes behind; while the monarch

31
Cortes rules the empire.

32
By a pretence, he obtains leave to build two brigantines on the lake.

monarch exulted in the victory of the Spaniards, without once conſidering that now he had effectually rivetted his own chains.

33 Montezuma owns himſelf a vaſſal to the king of Spain.

Cortes having obtained this important point, reſolved to put the condeſcenſion of the emperor to a trial ſtill more ſevere. He urged Montezuma to acknowledge himſelf a vaſſal to the crown of Caſtile; to hold his crown of him as ſuperior, and to ſubject his dominions to the payment of an annual tribute. With this requiſition, humiliating as it was, Montezuma complied. He called together the chief men of his empire, and, in a ſolemn harangue, reminded them of the traditions and prophecies which led them to expect the arrival of a people ſprung from the ſame ſtock with themſelves, in order to take poſſeſſion of the ſupreme power; he declared his belief that the Spaniards were this promiſed race; and that therefore he recognized the right of their monarch to govern the Mexican empire, would lay his crown at his feet, and obey him as a tributary. While uttering theſe words, Montezuma diſcovered how deeply he was affected in making ſuch a ſacrifice. Tears and groans frequently interrupted his diſcourſe. The firſt mention of ſuch a reſolution ſtruck the aſſembly dumb with aſtoniſhment. This was followed by a ſullen murmur of ſorrow mingled with indignation; which indicated ſome violent eruption of rage to be near at hand. This Cortes foreſaw, and ſeaſonably interpoſed to prevent it, by declaring that his maſter had no intention to deprive Montezuma of the royal dignity, or to make any innovation upon the conſtitution and laws of the Mexican empire. This aſſurance, added to their dread of the Spaniſh arms, and the authority of their monarch's example, extorted the conſent of the aſſembly; and the act of ſubmiſſion and homage was executed with all the formalities which the Spaniards pleaſed to preſcribe.

34 The Spaniards divide their treaſure.

Montezuma, at the requeſt of Cortes, accompanied this profeſſion of fealty and homage with a magnificent preſent to his new ſovereign; and, after his example, his ſubjects brought in very liberal contributions. The Spaniards then collected all the treaſure which had been either voluntarily beſtowed upon them at different times by Montezuma, or had been extorted from his people under various pretences; and having melted the gold and ſilver, the value of theſe, without including jewels and ornaments of various kinds, which were preſerved on account of their curious workmanſhip, amounted to 600,000 peſos. The ſoldiers were impatient to have it divided; and Cortes complied with their deſire. A fifth of the whole was ſet apart as the tax due to the king. Another fifth was allowed to Cortes, as commander. The ſums advanced by the governor of Cuba, who had originally fitted out the expedition, were then deducted. The remainder was then divided among the army, including the garriſon of Vera Cruz, in proportion to their different ranks; and after ſo many deductions, the ſhare of a private man did not exceed 100 peſos. This ſum fell ſo far below their ſanguine expectations, that it required all the addreſs, and no ſmall exertions of the liberality of Cortes to prevent an open mutiny. However, he at laſt reſtored tranquillity; but had no ſooner eſcaped this danger, than he involved himſelf, by his imprudent zeal for religion, in one much worſe. Montezuma, though often importuned, had obſtinately refuſed to change his religion, or aboliſh the ſuperſtitious rites which had been for ſuch a long time practiſed throughout his dominions. This at laſt tranſported the Spaniard with ſuch rage, that, in a ſally of zeal, he led out his ſoldiers in order to throw down the idols in the great temple by force. But the prieſts taking arms in defence of their altars, and the people crowding with great ardour to ſupport them, Cortes's prudence over-ruled his zeal; and induced him to deſiſt from his raſh attempt, after diſlodging the idols from one of the ſhrines, and placing in their ſtead an image of the Virgin Mary.

35 Cortes attempts to deſtroy the Mexican idols.

36 Which produces a general diſaffection.

From this moment the Mexicans began to meditate the expulſion or the deſtruction of the Spaniards. The prieſts and leading men held frequent meetings with Montezuma for this purpoſe. But as any violent attempt might have proved fatal to the captive monarch, it was thought proper firſt to try more gentle means. Having called Cortes into his preſence, he obſerved, that now, as all the purpoſes of his embaſſy were fully accompliſhed, the gods had declared their will, and the people ſignified their deſire, that he and his followers ſhould inſtantly depart out of the empire. With this he required them to comply, or unavoidable deſtruction would fall ſuddenly on their heads. This unexpected requiſition, as well as the manner in which it was delivered, alarmed Cortes. However, he ſuppoſed that more might be gained by a feigned compliance than by open reſiſtance; and therefore replied with great compoſure, that he had already begun to prepare for his return; but as he had deſtroyed the veſſels in which he arrived, ſome time was requiſite for building other ſhips. This appeared reaſonable; and a number of Mexicans were ſent to Vera Cruz to cut down timber, and ſome Spaniſh carpenters were appointed to ſuperintend the work.

37 The Spaniards are commanded to depart.

38 An armament ſent from Cuba againſt Cortes.

Cortes flattered himſelf that, during this interval, he might either find means to avert the threatened danger, or receive ſuch reinforcements as would enable him to defend himſelf. Nine months had now elapſed ſince Portocarrero and Montejo had ſailed with his diſpatches to Spain; and he daily expected a return with a confirmation of his authority from the king, without which all that he had done ſerved only to mark him out as an object of puniſhment. While he remained in great anxiety on this account, news were brought that ſome ſhips had appeared on the coaſt. Theſe were imagined by Cortes to be a reinforcement ſent him from Spain: but his joy was of ſhort continuance, for a courier very ſoon arrived from Vera Cruz, with certain information that the armament was fitted out by Velaſquez, the governor of Cuba; and inſtead of bringing ſuccours, threatened them with immediate deſtruction.

Velaſquez had been excited to this hoſtile meaſure chiefly through the indiſcretion, or rather treachery, of the meſſengers of Cortes; who, contrary to his expreſs injunctions, had landed on the iſland of Cuba, and given intelligence of all that had paſſed; and Velaſquez, tranſported with rage at hearing of the proceedings of Cortes, had now ſent againſt him this armament; conſiſting of 18 ſhips, which carried 80 horſemen, 800 infantry, of which 80 were muſketeers, and 120 croſs-bowmen, commanded by a brave officer named *Pamphilo de Narvaez;* whoſe inſtructions were, to ſeize Cortes and his principal officers, to ſend them

priſoners

Mexico.

priſoners to him, and then to complete the diſcovery and conqueſt of the country in his name. This proved a moſt afflicting piece of news to Cortes. However, thinking it imprudent to attempt any thing againſt his countrymen at firſt by force, he ſent his chaplain, Olmedo, with propoſals of accommodation. Narvaez rejected his propoſals with ſcorn; but his followers were leſs violent in their reſentments. Olmedo delivered many letters to them, either from Cortes himſelf, or from his officers, their ancient friends and companions. Theſe Cortes had artfully accompanied with preſents of rings, chains of gold, and other trinkets of value; which inſpired thoſe needy adventurers with high ideas of the wealth he had acquired, and with envy of the good fortune of thoſe who were engaged in his ſervice. Some, from hopes of becoming ſharers in theſe rich ſpoils, declared for an immediate accommodation; while others were for the ſame pacific meaſure, through fear of ſubverting the Spaniſh power entirely in a country where it was ſo imperfectly eſtabliſhed. Narvaez diſregarded both; and, by a proclamation, denounced Cortes and his adherents rebels, and enemies to their country.

39 Which is defeated by that general.

Cortes having now no reſource but in war, left 150 men under the command of Pedro de Alvarado, an officer of great bravery, and much reſpected by the Mexicans, to guard the capital, and the captive emperor; while he himſelf marched with the remainder to meet his formidable opponent, who had taken poſſeſſion of Zempoalla. Even after being reinforced by Sandoval his governor of Vera Cruz, the force of Cortes did not exceed 250 men. He hoped for ſucceſs chiefly from the rapidity of his motions and the poſſibility of ſurpriſing his enemies; and as he chiefly dreaded their cavalry, he armed his ſoldiers with long ſpears; accuſtoming them to that deep and compact arrangement which the uſe of this formidable weapon enabled them to aſſume. As he advanced, however, he repeated his propoſals of accommodation; but theſe being conſtantly rejected, and a price ſet upon his head, he at laſt attacked Narvaez in the night-time, entirely defeated and took him priſoner, obliging all his troops to own allegiance to himſelf.

Nothing could be more ſeaſonable than this victory, by which Cortes found his army very conſiderably increaſed; for moſt of the ſoldiers of Narvaez choſe rather to follow Cortes than to return to Cuba, whither the conqueror had offered to ſend them if they choſe. His affairs at Mexico, in the mean time, were in the utmoſt danger of being totally ruined; and had this deciſive victory been delayed but a few days longer, he muſt have come too late to ſave his companions. A ſhort time after the defeat of Narvaez, a courier arrived from Mexico with the diſagreeable intelligence that the Mexicans had taken arms; and having ſeized and deſtroyed the two brigantines which he had built in order to ſecure the command of the lake, had attacked the Spaniards in their quarters, killed ſome, and wounded many more, burnt their magazine of proviſions, and, in ſhort, carried on hoſtilities with ſuch fury, that though Alvarado and his men defended themſelves with undaunted reſolution, they muſt either be cut off by famine, or ſink under the multitude of their enemies. This revolt was excited by motives which rendered it ſtill more alarming. On the departure of Cortes for Zempoalla, the Mexicans flattered themſelves, that the long-expected opportunity of reſtoring their ſovereign to liberty, and driving out the Spaniards, was arrived; and conſultations were accordingly held for bringing about both theſe events. The Spaniards in Mexico, conſcious of their own weakneſs, ſuſpected and dreaded theſe machinations; but Alvarado, who had neither the prudence nor the addreſs of Cortes, took the worſt method imaginable to overcome them. Inſtead of attempting to ſooth or cajole the Mexicans, he waited the return of one of their ſolemn feſtivals, when the principal perſons in the empire were dancing, according to cuſtom, in the court of the great temple; he ſeized all the avenues which led to it; and, allured partly by the rich ornaments which they wore in honour of their gods, and partly by the facility of cutting off at once the authors of that conſpiracy which he dreaded, he fell upon them, unarmed and unſuſpicious of danger, and maſſacred a great number; none eſcaping, but ſuch as made their way over the battlements of the temple. An action ſo cruel and treacherous filled not only the city, but the whole empire, with indignation and rage; and the Mexicans immediately proceeded in the manner above-mentioned.

40 Dangerous situation of the Spaniards left at Mexico.

41 Cortes allowed to return to Mexico.

Cortes advanced with the utmoſt celerity to the relief of his diſtreſſed companions; but as he paſſed along, had the mortification to find that the Spaniards were generally held in abhorrence. The principal inhabitants had deſerted the towns through which he paſſed; no perſon of note appeared to meet him with the uſual reſpect, nor were proviſions brought to his camp as uſual. Notwithſtanding theſe ſigns of averſion and horror, however, the Mexicans were ſo ignorant of the militray art, that they again permitted him to enter the capital without oppoſition; though it was in their power to have eaſily prevented him, by breaking down the bridges and cauſeways which led to it.

Cortes was received by his companions with the utmoſt joy; and this extraordinary ſucceſs ſo far intoxicated the general himſelf, that he not only neglected to viſit Montezuma, but expreſſed himſelf very contemptuouſly concerning him. Theſe expreſſions being reported among the Mexicans, they all at once flew to arms, and made ſuch a violent and ſudden attack, that all the valour and ſkill of Cortes were ſcarce ſufficient to repell them. This produced great uneaſineſs among the ſoldiers of Narvaez, who had imagined there was nothing to do but to gather the ſpoils of a conquered country. Diſcontent and murmurings, however, were now of no avail; they were incloſed in an hoſtile city, and, without ſome extraordinary exertions, were inevitably undone. Cortes therefore made a deſperate ſally; but, after exerting his utmoſt efforts for a whole day, was obliged to retire with the loſs of 12 killed, and upwards of 60 wounded. Another ſally was attempted with the like bad ſucceſs, and in it Cortes himſelf was wounded in the hand.

42 But is furiouſly attacked by the natives.

The Spaniſh general was now thoroughly convinced of his error; and therefore betook himſelf to the only reſource which was left; namely, to try what effect the interpoſition of Montezuma would have to ſooth or overawe his ſubjects. When the Mexicans approached the next morning to renew the aſſault, that

Mexico. that unfortunate prince, at the mercy of the Spaniards, and reduced to the sad necessity of becoming the instrument of his own disgrace, and of the slavery of his people, advanced to the battlements in his royal robes, and with all the pomp in which he used to appear on solemn occasions. At the sight of their sovereign, whom they had been long accustomed to reverence almost as a god, the Mexicans instantly forebore their hostilities, and many prostrated themselves on the ground: but when he addressed them in favour of the Spaniards, and made use of all the arguments he could think of to mitigate their rage, they testified their resentment with loud murmurings; and at length broke forth with

43 Montezuma killed.

such fury, that before the soldiers, appointed to guard Montezuma, had time to cover him with their shields, he was wounded with two arrows, and a blow on his temple with a stone struck him to the ground. On seeing him fall, the Mexicans instantly fled with the utmost precipitation: but the unhappy monarch, now convinced that he was become an object of contempt even to his own subjects, obstinately refused all nourishment; and thus in a short time ended his days.

44 A terrible engagement between the Spaniards and Mexicans.

On the death of Montezuma, Cortes having lost all hope of bringing the Mexicans to any terms of peace, prepared for retreat. But his antagonists, having taken possession of a high tower in the great temple, which overlooked the Spanish quarters, and placing there a garrison of their principal warriors, the Spaniards were so much exposed to their missile weapons, that none could stir without danger of being killed or wounded. From this post, therefore, it was necessary to dislodge them at any rate; and Juan de Escobar, with a large detachment of chosen soldiers, was ordered to make the attack. But Escobar, though a valiant officer, and though he exerted his utmost efforts, was thrice repulsed. Cortes, however, sensible, that not only his reputation, but the safety of his army, depended on the success of this assault, caused a buckler to be tied to his arm, as he could not manage it with his wounded hand, and rushed with his drawn sword among the thickest of the combatants. Encouraged by the presence of their general, the Spaniards returned to the charge with such vigour, that they gradually forced their way up the steps, and drove the Mexicans to the platform at the top of the tower. There a dreadful carnage began; when two young Mexicans of high rank, observing Cortes, as he animated his soldiers, resolved to sacrifice their own lives in order to cut off the author of so many calamities which desolated their country. They approached him in a suppliant posture, as if they intended to lay down their arms, and seizing him in a moment, hurried him towards the battlements, over which they threw themselves headlong, in hopes of dragging him along with them. But Cortes, by his strength and agility, disengaged himself from their grasp; so that the two Mexicans perished alone.

As soon as the Spaniards became masters of the tower, they set fire to it, and without further molestation continued the preparations for their retreat. This became the more necessary, as their emenies, astonished at this last effort of their valour, had now entirely changed their system of hostility; and, instead of incessant attacks, endeavoured, by barricading the streets, and breaking down the causeways, to cut off the communication of the Spaniards with the continent, and thus to starve an enemy whom they could not subdue. The first point to be determined was whether they should march out openly in the face of day, when they could discern every danger, or whether they should endeavour to retire secretly in the night. The latter was preferred, partly from hopes that the superstition of the Mexicans would prevent them from attacking them in the night, and partly from their own superstition in giving credit to the predictions of a private soldier, who pretended to astrology, and assured them of success if they retreated in this manner. Towards midnight, therefore, they began their march, in three divisions. Sandoval led the van; Pedro Alvarado and Veles Guez de Lean had the conduct of the rear; and Cortes commanded in the centre, where he placed the prisoners, among whom were a son and two daughters of Montezuma, together with several Mexicans of distinction; the artillery, baggage, and a portable bridge of timber intended to be laid over the breaches in the causeway. They marched in profound silence along the causeway which led to Tacuba, because it was shorter than any of the rest, and, lying most remote from the road towards Tlascala and the sea-coast, had been left most entire by the Mexicans.

They reached the first breach in the causeway without molestation, hoping that their retreat was undiscovered. But the Mexicans had not only watched all their motions, but made preparations for a most formidable attack. While the Spaniards were intent upon placing their bridges in the breach, and occupied in conducting their horses and artillery along it, they were suddenly alarmed with the sound of warlike instruments, and found themselves assaulted on all sides by an innumerable multitude of enemies. Unfortunately the wooden bridge was wedged so fast in the mud by the weight of the artillery, that it was impossible to remove it. Dismayed at this accident, the Spaniards advanced with precipitation to the second breach. The Mexicans hemmed them in on every side; and though they defended themselves with their usual courage, yet, crowded as they were in a narrow causeway, their discipline and military skill were of little avail; nor did the obscurity of the night allow them to derive much advantage from their fire-arms or the superiority of their other weapons. At last the Spaniards, overborne with the numbers of their enemies, began to give way, and in a moment the confusion was universal. Cortes, with about 100 foot-soldiers, and a few horse, forced his way over the two remaining breaches in the causeway, the bodies of the dead serving to fill up the chasms, and reached the main land. Having formed them as soon as they arrived, he returned with such as were yet capable of service, to assist his friends in their retreat. He met with part of his soldiers who had forced their way through the enemy, but found many more overwhelmed by the multitude of their aggressors, or perishing in the lake; and heard the grievous lamentations of others whom the Mexicans were carrying off in triumph, to be sacrificed to the god of war.

45 Cortes retreats with great loss.

In this fatal retreat more than one half of Cortes's army perished, together with many officers of distinction. All the artillery, ammunition, and baggage were

Mexico were loſt; the greater part of the horſes and above 2000 Tlaſcalans were killed, and only a very ſmall part of their treaſure ſaved. The firſt care of the Spaniſh general was to find ſome ſhelter for his wearied troops; for, as the Mexicans infeſted them on every ſide, and the people of Tacuba began to take arms, he could not continue in his preſent ſtation. At laſt he diſcovered a temple ſeated on an eminence, in which he found not only the ſhelter he wanted, but ſome proviſions; and though the enemy did not intermit their attacks throughout the day, they were without much difficulty prevented from making any impreſſion. For ſix days after, they continued their march through a barren, ill-cultivated, and thinly-peopled country, where they were often obliged to feed on berries, roots, and the ſtalks of green maize; at the ſame time they were haraſſed without intermiſſion by large parties of Mexicans, who attacked them on all ſides. On the ſixth day they reached Otumba, not far from the road between Mexico and Tlaſcala. Early next morning they began to advance towards it, flying parties of the enemy ſtill hanging on their rear; and amidſt the inſults with which they accompanied their hoſtilities, Donna Marina remarked, that they often exclaimed with exultation, "Go on, robbers; go to the place where you ſhall quickly meet the vengeance due to your crimes." The meaning of this threat the Spaniards did not comprehend, until they reached the ſummit of an eminence before them. There a ſpacious valley opened to their view, covered with a vaſt army as far as the eye could reach. The Mexicans, while with one body of their troops they haraſſed the Spaniards in their retreat, had aſſembled their principal force on the other ſide of the lake; and marching

46 The battle of Otumba. along the road which led directly to Tlaſcala, poſted it in the plain of Otumba, through which they knew Cortes muſt paſs. At the ſight of this incredible multitude, which they could ſurvey at once from the riſing ground, the Spaniards were aſtoniſhed, and even the boldeſt began to deſpair. But Cortes, without allowing their fears time to operate, after warning them briefly that no alternative remained but to conquer or die, led them inſtantly to the charge. The Mexicans waited their approach with unuſual fortitude: yet, ſuch was the ſuperiority of the Spaniſh diſcipline and arms, that the impreſſion of this ſmall body was irreſiſtible; and which ever way its force was directed, it penetrated and diſperſed the moſt numerous battalions. But while theſe gave way in one quarter, new combatants advanced from another; and the Spaniards, though ſucceſsful in every attack, were ready to ſink under theſe repeated efforts, without ſeeing any end to their toil, or any hope of victory. At that time Cortes obſerved the great ſtandard of the empire, which was carried before the Mexican general, advancing; and fortunately recollecting to have heard, that on the fate of it depended the event of every battle, he aſſembled a few of his braveſt officers, whoſe horſes were ſtill capable of ſervice, and, placing himſelf at their head, puſhed towards the ſtandard with ſuch impetuoſity that he bore down every thing before him. A choſen body of nobles, who guarded the ſtandard, made ſome reſiſtance, but were ſoon broken. Cortes, with a ſtroke of his lance, wounded the Mexican general, and threw him to the ground. One of his followers alighting, put an end to his life, and laid hold of the imperial ſtandard. The moment that their leader fell, and the ſtandard, towards which all directed their eyes, diſappeared, an univerſal panic ſtruck the Mexicans; and, as if the bond which held them together had been diſſolved, every enſign was lowered, each ſoldier threw away his weapons, and fled with precipitation to the mountains. The Spaniards, unable to purſue them far, returned to collect the ſpoils of the field; and theſe were ſo valuable as to be ſome compenſation for the wealth which they had loſt in Mexico; for in the enemy's army were moſt of their principal warriors dreſſed out in their richeſt ornaments, as if they had been marching to aſſured victory. Mexico. 47 Mexicans defeated.

The day after this important action, (being July 8th 1520), the Spaniards entered the Tlaſcalan territories, where they were received with the moſt cordial friendſhip. Cortes endeavoured to avail himſelf of this diſpoſition as much as poſſible; for which purpoſe he diſtributed among them the rich ſpoils taken at Otumba with ſuch a liberal hand, that he made himſelf ſure of obtaining from the republic whatever he ſhould deſire. He drew a ſmall ſupply of ammunition, and two or three field-pieces from his ſtores at Vera Cruz. He diſpatched an officer of confidence with four ſhips of Narvaez's fleet to Hiſpaniola and Jamaica, to engage adventurers, and to purchaſe horſes, gunpowder, and other military ſtores. And, as he knew that it would be in vain to attempt the reduction of Mexico, unleſs he could ſecure the command of the lake, he gave orders to prepare, in the mountains of Tlaſcala, materials for building 12 brigantines, ſo that they might be carried thither in pieces, ready to be put together, and launched when he ſtood in need of their ſervice. But, in the mean time, his ſoldiers, alarmed at the thoughts of being expoſed to ſuch calamities a ſecond time, preſented a remonſtrance to their general, in which they repreſented the imprudence of attacking a powerful empire with his ſhattered forces, and formally required him to return back to Cuba. All the eloquence of Cortes could now only prevail with them to delay their departure for ſome time, when he promiſed to diſmiſs ſuch as ſhould deſire it. However, this was only a pretence; for Cortes, in fact, had the conqueſt of Mexico as much at heart as ever. Without giving his ſoldiers an opportunity of caballing, therefore, he daily employed them againſt the people of the neighbouring provinces, who had cut off ſome detachments of Spaniards during his misfortunes at Mexico; and by which, as he was conſtantly attended with ſucceſs, his men ſoon reſumed their wonted ſenſe of ſuperiority. 48

But all the efforts of Cortes could have been of little avail, had he not unexpectedly obtained a reinforcement of Spaniſh ſoldiers. The governor of Cuba, to whom the ſucceſs of Narvaez appeared an event of infallible certainty, having ſent two ſmall ſhips after him with new inſtructions, and a ſupply of men and military ſtores, the officer whom Cortes had appointed to command on the coaſt, artfully decoyed them into the harbour of Vera Cruz, ſeized the veſſels, and eaſily perſuaded the ſoldiers to follow the ſtandard of a more able leader than him whom they were deſtined to join. Soon after, three ſhips of more conſiderable force came into the harbour ſeparately. Theſe belonged to an Cortes receives an unexpected reinforcement.

Mexico. an armament fitted out by Francifco de Garay, governor of Jamaica, who had long aimed at dividing with Cortes the glory and gain of annexing the empire of Mexico to the crown of Caftile. They had, however, unadvifedly made their attempt on the northern provinces, where the country was poor, and the inhabitants fierce and warlike; fo that, after a fucceffion of difafters, they were now obliged to venture into Vera Cruz, and caft themfelves upon the mercy of their countrymen; and here they alfo were foon perfuaded to throw off their allegiance to their mafter, and to enlift with Cortes. About the fame time a fhip arrived from Spain, freighted by fome private adventurers, with military ftores; and the cargo was eagerly purchafed by Cortes, while the crew, following the example of the reft, joined him at Tlafcala.

From thefe various quarters, the army of Cortes was augmented with 180 men, and 20 horfes; by which means he was enabled to difmifs fuch of the foldiers of Narvaez as were moft troublefome and difcontented; after the departure of whom, he ftill mustered 550 infantry, of whom 80 were armed with mufkets or crofs-bows, 40 horfemen, and nine pieces of

49
He fets out again for Mexico.

artillery. At the head of thefe, with 10,000 Tlafcalans and other friendly Indians, he began his march towards Mexico, on the 28th of December, fix months after his fatal retreat from that city.

The Mexicans, in the mean time, had made the beft preparations they could for oppofing fuch a formidable enemy. On the death of Montezuma, his brother Quetlavaca was raifed to the throne; and he had an immediate opportunity of fhewing that he was worthy of their choice, by conducting in perfon thofe fierce attacks which obliged the Spaniards to retire from his

50
Preparations of the Mexicans for their defence.

capital. His prudence in guarding againft the return of the invaders was equal to the fpirit he had fhewn in driving them out. He repaired what the Spaniards had ruined in the city, ftrengthened it with fuch fortifications as his people could erect; and befides filling his magazines with the ufual weapons of war, gave directions to make long fpears, headed with the fwords and daggers which they had taken from the Spaniards, in order to annoy the cavalry. But in the midft of thefe preparations he was taken off by the fmall-pox; and Guatimozin, his nephew and fon-in-law, raifed to the throne.

As foon as Cortes entered the enemy's territories, he difcovered various preparations to obftruct his progrefs. But his troops forced their way with little difficulty; and took poffeffion of Tezeuco, the fecond city of the empire, fituated on the banks of the lake, about 20 miles from Mexico. Here he determined to eftablifh his head-quarters, as the moft proper ftation for lanching his brigantines, as well as for making his approaches to the capital. In order to render his refidence there more fecure, he depofed the cazique or chief, who was at the head of that community, under pretence of fome defect in his title, and fubftituted in his place a perfon whom a faction of the nobles pointed out as the right heir of that dignity. Attached to him by this benefit, the new cazique and his adherents ferved the Spaniards with inviolable fidelity.

As the conftruction of the brigantines advanced flowly under the unfkilful hands of foldiers and Indians, whom Cortes was obliged to employ in affifting three or four carpenters who happened fortunately to be in his fervice, and as he had not yet received the reinforcement which he expected from Hifpaniola, he was not in a condition to turn his arms directly againft the capital. To have attacked a city fo populous, fo well prepared for defence, and in a fituation of fuch peculiar ftrength, muft have expofed his troops to inevitable deftruction. Three months elapfed before the materials for conftructing the brigantines were finifhed, and before he heard any thing with refpect to the fuccefs of his negotiation in Hifpaniola. This, however, was not a feafon of inaction to Cortes. He at- 51

Cortes makes great progrefs.

tacked fucceffively feveral of the towns fituated around the lake; and though all the Mexican power was exerted to obftruct his operations, he either compelled them to fubmit to the Spanifh crown, or reduced them to ruins. Other towns he endeavoured to conciliate by more gentle means; and though he could not hold any intercourfe with the inhabitants but by the intervention of interpreters, yet, under all the difadvantage of that tedious and imperfect mode of communication, he had acquired fuch thorough knowledge of the ftate of the country, as well as of the difpofitions of the people, that he conducted his negotiations and intrigues with aftonifhing dexterity and fuccefs. Moft of the cities adjacent to Mexico were originally the capitals of fmall independent ftates; and fome of them having been but lately annexed to the Mexican empire, ftill retained the remembrance of their ancient liberty, and bore with impatience the rigorous yoke of their new mafters. Cortes having early obferved fymptoms of their difaffection, availed himfelf of this knowledge to gain their confidence and friendfhip. By offering with confidence to deliver them from the odious dominion of the Mexicans, and by liberal promifes of more indulgent treatment if they would unite with him againft their oppreffors, he prevailed on the people of feveral confiderable diftricts, not only to acknowledge the king of Caftile as their fovereign, but to fupply the Spanifh camp with provifions, and to ftrengthen his army with auxiliary troops. Guatimozin, on the firft appearance of defection among his fubjects, exerted himfelf with vigour to prevent or to punifh their revolt; but, in fpite of his efforts, the fpirit continued to fpread. The Spaniards gradually acquired new allies; and with deep concern he beheld Cortes arming againft his empire thofe very hands which ought to have been active in his defence, and ready to advance againft the capital at the head of a numerous body of his own fubjects.

While, by thofe various methods, Cortes was gradually circumfcribing the Mexican power within fuch narrow limits that his profpect of overturning it feemed neither to be uncertain nor remote, all his fchemes were well nigh defeated by a confpiracy againft his own perfon, and which was difcovered only a fhort time before it was to have been executed. Though many were concerned, Cortes did not think proper to punifh any more than the principal ringleader, whom he caufed immediately to be hanged; and then, without allowing them leifure to ruminate on what had happened, and as the moft effectual means of preventing the return of a mutinous fpirit, he determined to call forth his troops immediately to action. Fortunately, a proper occafion for this occurred, without his feeming to

Mexico.

to court it. He received intelligence, that the materials for building the brigantines were at length completely finished, and waited only for a body of Spaniards to conduct them to Tezeuco. The command of this convoy, consisting of 200 foot-soldiers, 15 horsemen, and 2 field-pieces, he gave to Sandoval, who, by the vigilance, activity, and courage, which he manifested on every occasion, was growing daily in his confidence, and in the estimation of his fellow-soldiers. The service was no less singular than important; the beams, the planks, the masts, the cordage, the sails, the iron-work, and all the infinite variety of articles requisite for the construction of 13 brigantines, were to be carried 60 miles over land, thro' a mountainous country, by people who were unacquainted with the ministry of domestic animals, or the aid of machines to facilitate any work of labour. The Tlascalans furnished 8000 *Tamenes*, an inferior order of men destined for servile tasks, to carry the materials on their shoulders, and appointed 15,000 warriors to accompany and defend them. Sandoval made the disposition for their progress with great propriety, placing the Tamenes in the centre, one body of warriors in the front, another in the rear, with considerable parties to cover the flanks. To each of these he joined some Spaniards, not only to assist them in danger, but to accustom them to regularity and subordination. Parties of Mexicans frequently appeared hovering around them on the high grounds: but perceiving no prospect of success in attacking an enemy continually on his guard, and prepared to receive them, they did not venture to molest him; and Sandoval had the glory of conducting safely to Tezeuco, a convoy on which all the future operations of his countrymen depended.

52
The Spaniards receive another reinforcement.

This was followed by another event of no less moment. Four ships arrived at Vera Cruz from Hispaniola, with 200 soldiers, 80 horses, two battering cannon, and a considerable supply of ammuniton and arms. Elevated with observing that all his preparatory schemes, either for recruiting his own army, or impairing the force of the enemy, had now produced their full effect, Cortes, impatient to begin the siege in form, hastened the launching of the brigantines. To facilitate this, he had employed a vast number of Indians, for two months, in deepening the small rivulet which runs by Tezeuco into the lake, and in forming it into a canal near two miles in length: and though the Mexicans, aware of his intentions, as well as of the danger which threatened them, endeavoured frequently to interrupt the labourers, or to burn the brigantines, the work was at last completed. On the 28th of April, all the Spanish troops, together with auxiliary Indians, were drawn up on the banks of the canal; and with extraordinary military pomp, heightened and rendered more solemn by the celebration of the most sacred rites of religion, the brigantines were launched. As they fell down the canal in order, Father Olmedo blessed them, and gave each its name. Every eye followed them with wonder and hope, until they entered the lake, when they hoisted their sails, and bore away before the wind. A general shout of joy was raised; all admiring that bold inventive genius, which, by means so extraordinary, that their success almost exceeded belief, had acquired the command of a fleet, without the aid of which Mexico would have continued to set the Spanish power and arms at defiance.

Mexico.

53
The city besieged.

Cortes determined to attack the city from three different quarters; from Tezeuco on the east side of the lake, from Tacuba on the west, and from Cuyocan towards the south. Those towns were situated on the principal causeways which led to the capital, and intended for their defence. He appointed Sandoval to command in the first, Pedro de Alvarado in the second, and Christoval de Olid in the third; allotting to each a numerous body of Indian auxiliaries, together with an equal division of Spaniards, who, by the junction of the troops from Hispaniola, amounted now to 86 horsemen, and 818 foot-soldiers; of whom 118 were armed with muskets or cross-bows. Their train of artillery consisted of three battering cannon, and 15 field-pieces. He reserved for himself, as the station of greatest importance and danger, the conduct of the brigantines, each armed with one of his small cannon, and manned with 25 Spaniards.

As Alvarado and Olid proceeded towards the posts assigned them, they broke down the aqueducts which the ingenuity of the Mexicans had erected for conveying water into the capital, and, by the distress to which this reduced the inhabitants, gave a beginning to the calamities which they were destined to suffer. Alvarado and Olid found the towns, of which they were ordered to take possession, deserted by their inhabitants, who had fled for safety to the capital, where Guatimozin had collected the chief force of his empire, as there alone he could hope to make a succesful stand against the formidable enemies who were approaching to assault him.

54
The Spaniards defeat the Mexicans, and become masters of the lake.

The first effort of the Mexicans was to destroy the fleet of brigantines, the fatal effects of whose operations they foresaw and dreaded. Though the brigantines, after all the labour and merit of Cortes in forming them, were of inconsiderable bulk, rudely constructed, and manned chiefly with landmen, hardly possessed of skill enough to conduct them, they must have been objects of terror to a people unacquainted with any navigation but that of their lake, and possessed of no vessel larger than a canoe. Necessity, however, urged Guatimozin to hazard the attack; and hoping to supply by numbers what he wanted in force, he assembled such a multitude of canoes as covered the face of the lake. They rowed on boldly to the charge, while the brigantines, retarded by a dead calm, could scarcely advance to meet them. But as the enemy drew near, a breeze suddenly sprung up; in a moment the sails were spread, and the brigantines with irresistible impetuosity broke their feeble opponents, overset many canoes, and dissipated the whole armament with such slaughter, as convinced the Mexicans, that the progress of the Europeans in knowledge and arts rendered their superiority greater on this new element than they had hitherto found it by land.

From that time Cortes remained master of the lake; and the brigantines not only preserved a communication between the Spaniards in their different stations, though at considerable distance from each other; but were employed to cover the causeways on each side, and keep off the canoes, when they attempted to annoy the troops as they advanced towards the city. He formed

Mexico.

formed the brigantines in three divisions, allotting one to each station, with orders to second the operations of the officer who commanded there. From all the three stations he pushed on the attack against the city with equal vigour; but in a manner so very different from that whereby sieges are conducted in regular war, as might appear no less improper than singular to persons unacquainted with his situation. Each morning his troops assaulted the barricades which the enemy had erected on the causeways, forced their way over the trenches which they had dug, and thro' the canals where the bridges were broken down, and endeavoured to penetrate into the heart of the city, in hopes of obtaining some decisive advantage, which might force the enemy to surrender, and terminate the war at once; but when the obstinate valour of the Mexicans rendered the efforts of the day ineffectual, the Spaniards retired in the evening to their former quarters. Thus their toil and danger were, in some measure, continually renewed; the Mexicans repairing in the night what the Spaniards had destroyed through the day, and recovering the posts from which they had driven them. But necessity prescribed this slow and untoward mode of operation. The number of his troops was so small, that Cortes durst not, with a handful of men, attempt to make a lodgment in a city where he might be surrounded and annoyed by such a multitude of enemies. The remembrance of what he had already suffered by the ill-judged confidence with which he had ventured into such a dangerous situation, was still fresh in his mind. The Spaniards, exhausted with fatigue, were unable to guard the various posts which they daily gained; and though their camp was filled with Indian auxiliaries, they durst not devolve this charge upon them, because they were so little accustomed to discipline, that no confidence could be placed in their vigilance. Besides this, Cortes was extremely solicitous to preserve the city as much as possible from being destroyed, both as he destined it to be the capital of his conquests, and wished that it might remain as a monument of his glory. From all these considerations, he adhered obstinately, for a month after the siege was opened, to the system which he had adopted. The Mexicans, in their own defence, displayed valour which was hardly inferior to that with which the Spaniards attacked them. On land, on water, by night and by day, one furious conflict succeeded to another. Several Spaniards were killed, more wounded, and all were ready to sink under the toils of unintermitting service, which were rendered more intolerable by the injuries of the season, the periodical rains being now set in with their usual violence.

Astonished and disconcerted with the length and difficulties of the siege, Cortes determined to make one great effort to get possession of the city before he relinquished the plan which he had hitherto followed, and had recourse to any other mode of attack. With this view, he sent instructions to Alvarado and Sandoval to advance with their divisions to a general assault, and took the command in person of that posted on the causeway of Cuyocan. Animated by his presence, and the expectation of some decisive event, the Spaniards pushed forward with irresistible impetuosity. They broke through one barricade after another, forced their way over the ditches and canals, and having entered the city, gained ground incessantly, in spite of the multitude and ferocity of their opponents. Cortes, though delighted with the rapidity of his progress, did not forget that he might still find it necessary to retreat; and in order to secure it, appointed Julian de Alderete, a captain of chief note in the troops which he had received from Hispaniola, to fill up the canals and gaps in the causeway as the main body advanced. That officer deeming it inglorious to be thus employed, while his companions were in the heat of action and the career of victory, neglected the important charge committed to him, and hurried on inconsiderately to mingle with the combatants. The Mexicans, whose military attention and skill were daily improving, no sooner observed this, than they carried an account of it to their monarch.

Guatimozin instantly discerned the consequences of the error which the Spaniards had committed, and, with admirable presence of mind, prepared to take advantage of it. He commanded the troops posted in the front to slacken their efforts, in order to allure the Spaniards to push forward, while he dispatched a large body of chosen warriors through different streets, some by land, and others by water, towards the great breach in the causeway, which had been left open. On a signal which he gave, the priests in the great temple struck the great drum consecrated to the god of war. No sooner did the Mexicans hear its doleful solemn sound, calculated to inspire them with contempt of death and with enthusiastic ardour, than they rushed upon the enemy with frantic rage. The Spaniards, unable to resist men urged on no less by religious fury than hope of success, began to retire, at first leisurely, and with a good countenance; but as the enemy pressed on, and their own impatience to escape increased, the terror and confusion became so general, that when they arrived at the gap in the causeway, Spaniards and Tlascalans, horsemen and infantry, plunged in promiscuously, while the Mexicans rushed upon them fiercely from every side, their light canoes carrying them through shoals which the brigantines could not approach. In vain did Cortes attempt to stop and rally his flying troops; fear rendered them regardless of his intreaties or commands. 55 Cortes repulsed in an attack.
Finding all his endeavours to renew the combat fruitless, his next care was to save some of those who had thrown themselves into the water; but while thus employed, with more attention to their situation than to his own, six Mexican captains suddenly laid hold of him, and were hurrying him off in triumph; and tho' two of his officers rescued him at the expence of their own lives, he received several dangerous wounds before he could break loose. Above 60 Spaniards perished in the rout; and what rendered the disaster more afflicting, 40 of these fell alive into the hands of an enemy never known to shew mercy to a captive.

The approach of night, though it delivered the dejected Spaniards from the attacks of the enemy, ushered in, what was hardly less grievous, the noise of their barbarous triumph, and of the horrid festival with which they celebrated their victory. Every quarter of the city was illuminated; the great temple shone with such peculiar splendour, that the Spaniards could plainly

plainly ſee the people in motion, and the prieſts buſy in haſtening the preparations for the death of the priſoners. Through the gloom they fancied that they diſcerned their companions by the whiteneſs of their ſkins, as they were ſtripped naked and compelled to dance before the image of the god to whom they were to be offered. They heard the ſhrieks of thoſe who were ſacrificed, and thought they could diſtinguiſh each unhappy victim by the well-known ſound of his voice. Imagination added to what they really ſaw or heard, and augmented its horror. The moſt unfeeling melted into tears of compaſſion, and the ſtouteſt heart trembled at the dreadful ſpectacle which they beheld.

Cortes, who, beſides all that he felt in common with his ſoldiers, was oppreſſed with the additional load of anxious reflections natural to a general on ſuch an unexpected calamity, could not like them relieve his mind by giving vent to its anguiſh. He was obliged to aſſume an air of tranquillity in order to revive the ſpirits

56
The Mexicans renew the attack with great fury.

and hopes of his followers. The juncture, indeed, required an extraordinary exertion of fortitude. The Mexicans, elated with their victory, ſallied out next morning to attack him in his quarters. But they did not rely on the efforts of their own arms alone. They ſent the heads of the Spaniards whom they had ſacrificed to the leading men in the adjacent provinces, and aſſured them that the god of war, appeaſed by the blood of their invaders, which had been ſhed ſo plentifully on his altars, had declared with an audible voice, that in eight days time thoſe hated enemies ſhould be finally deſtroyed, and peace and proſperity re-eſtabliſhed in the empire.

A prediction, uttered with ſuch confidence, and in terms ſo void of ambiguity, gained univerſal credit among a people prone to ſuperſtition. The zeal of the provinces which had already declared againſt the Spaniards augmented, and ſeveral which had hitherto remained inactive took arms with enthuſiaſtic ardour to execute the decrees of the gods. The Indian auxiliaries who had joined Cortes, accuſtomed to venerate the ſame deities with the Mexicans, and to receive the reſponſes of their prieſts with the ſame implicit faith, abandoned the Spaniards as a race of men devoted to certain deſtruction. Even the fidelity of the Tlaſcalans was ſhaken, and the Spaniſh troops were left almoſt alone in their ſtations. Cortes finding that he attempted in vain to diſpel the ſuperſtitious fears of his confederates by argument, took advantage from the imprudence of thoſe who had framed the prophecy in fixing its accompliſhment ſo near at hand, to give them a ſtriking demonſtration of his falſity. He ſuſpended all military operations during the period marked out by the oracle. Under cover of the brigantines, which kept the army at a diſtance, his troops lay in ſafety, and the fatal term expired without any diſaſter.

His allies, aſhamed of their own credulity, returned to their ſtation. Other tribes, judging that the gods, who had now deceived the Mexicans, had decreed finally to withdraw their protection from them, joined

57
Cortes adopts a more cautious method of proceeding.

his ſtandard; and ſuch was the levity of a ſimple people, moved by every ſlight impreſſion, that, in a ſhort time after ſuch a general defection of his confederates, Cortes ſaw himſelf, if we may believe his own account, at the head of 150,000 Indians. Even with ſuch a numerous army, he found it neceſſary to adopt a new and more wary ſyſtem of operation. Inſtead of renewing his attempts to become maſter of the city at once, by ſuch bold but dangerous efforts of valour as he had already tried, he made his advances gradually, and with every poſſible precaution againſt expoſing his men to any calamity ſimilar to that which they ſtill bewailed. As the Spaniards puſhed forward, the Indians regularly repaired the cauſeways behind them. As ſoon as they got poſſeſſion of any part of the town, the houſes were inſtantly levelled with the ground. Day by day, the Mexicans, forced to retire as their enemies gained ground, were hemmed in within more narrow limits. Guatimozin, though unable to ſtop the career of the enemy, continued to defend his capital with obſtinate reſolution, and diſputed every inch of ground. But the Spaniards, having not only varied their mode of attack, but, by orders of Cortes, having changed the weapons with which they fought, were again armed with the long Chinantlan ſpears, which they had employed with ſuch ſucceſs againſt Narvaez; and, by the firm array in which this enabled them to range themſelves, they repelled, with little danger, the looſe aſſault of the Mexicans: incredible numbers of them fell in the conflicts, which they renewed every day. While war waſted without, famine began to conſume them within the city. The Spaniſh brigantines, having the entire command of the lake, rendered it impoſſible to receive any ſupply of proviſions by water. The vaſt number of his Indian auxiliaries enabled Cortes to ſhut up the avenues to the city by land. The ſtores which Guatimozin had laid up were exhauſted by the multitudes which crowded into the capital, to defend their ſovereign and the temples of their gods. Not only the people, but perſons of the higheſt rank, felt the utmoſt diſtreſſes of want. What they ſuffered brought on infectious and mortal diſtempers, the laſt calamity that viſits beſieged cities, and which filled up the meaſure of their woes.

58
Guatimozin refuſes to ſubmit on any terms.

But, under the preſſure of ſo many and ſuch various evils, the ſpirit of Guatimozin remained firm and unſubdued. He rejected with ſcorn every overture of peace from Cortes; and, diſdaining the idea of ſubmitting to the oppreſſors of his country, determined not to ſurvive its ruin. The Spaniards continued their progreſs. At length all the three diviſions penetrated into the great ſquare in the centre of the city, and made a ſecure lodgment there. Three-fourths of the city were now reduced, and laid in ruins. The remaining quarter was ſo cloſely preſſed, that it could not long withſtand aſſailants who attacked it from their new ſtation with ſuperior advantage, and more aſſured expectation of ſucceſs. The Mexican nobles, ſolicitous to ſave the life of a monarch whom they revered, prevailed on Guatimozin to retire from a place where reſiſtance was now vain, that he might rouſe the more diſtant provinces of the empire to arms, and maintain there a more ſucceſsful ſtruggle with the public enemy. In order to facilitate the execution of this meaſure, they endeavoured to amuſe Cortes with overtures of ſubmiſſion, that, while his attention was employed in adjuſting the articles of pacification, Guatimozin might eſcape unperceived. But they made this attempt upon a leader of greater ſagacity and diſcernment than to be deceived by their arts. Cortes ſuſpec-

Mexico. ting their intention, and aware of what moment it was to defeat it, appointed Sandoval, the officer on whoſe vigilance he could moſt perfectly rely, to take the command of the brigantines, with ſtrict injunctions to watch every motion of the enemy. Sandoval, attentive to the charge, obſerving ſome large canoes crowded with people rowing along the lake with extraordinary rapidity, inſtantly gave the ſignal to chace. Gracia Holguin, who commanded the fleeteſt brigantine, ſoon overtook them, and was preparing to fire on the foremoſt canoe, which ſeemed to carry ſome perſon whom all the reſt followed and obeyed. At once the rowers dropt their oars, and all on board,

59 He is taken priſoner. throwing down their arms, conjured him with cries and tears to forbear, as the emperor was there. Holguin eagerly ſeized his prize; and Guatimozin, with a dignified compoſure, gave himſelf up into his hands, requeſting only that no inſult might be offered to the empreſs or his children. When conducted to Cortes, he appeared neither with the ſullen fierceneſs of a barbarian, nor with the dejection of a ſupplicant. "I have done," ſaid he, addreſſing himſelf to the Spaniſh general, "what became a monarch. I have defended my people to the laſt extremity. Nothing now remains but to die. Take this dagger," laying his hand on one which Cortes wore, "plant it in my breaſt, and put an end to a life which can no longer be of uſe."

60 Mexico ſubmits. As ſoon as the fate of their ſovereign was known, the reſiſtance of the Mexicans ceaſed; and Cortes took poſſeſſion of that ſmall part of the capital which yet remained undeſtroyed. Thus terminated the ſiege of Mexico, the moſt memorable event in the conqueſt of America. It continued 75 days, hardly one of which paſſed without ſome extraordinary effort of one party in the attack, or of the other in the defence of a city, on the fate of which both knew that the fortune of the empire depended. As the ſtruggle here was more obſtinate, it was likewiſe more equal, than any between the inhabitants of the Old and New Worlds. The great abilities of Guatimozin, the number of his troops, the peculiar ſituation of his capital, ſo far counterbalanced the ſuperiority of the Spaniards in arms and diſcipline, that they muſt have relinquiſhed the enterpriſe, if they had truſted for ſucceſs to themſelves alone. But Mexico was overturned by the jealouſy of neighbours who dreaded its power, and by the revolt of ſubjects impatient to ſhake off its yoke. By their effectual aid, Cortes was enabled to accompliſh what, without ſuch ſupport, he would hardly have ventured to attempt. How much ſoever this account of the reduction of Mexico may detract, on the one hand, from the marvellous relations of ſome Spaniſh writers, by aſcribing that to ſimple and obvious cauſes which they attribute to the romantic valour of their countrymen, it adds, on the other, to the merit and abilities of Cortes, who, under every diſadvantage, acquired ſuch an aſcendant over unknown nations, as to render them inſtruments towards carrying his ſcheme into execution.

The exultation of the Spaniards, on accompliſhing this arduous enterpriſe, was at firſt exceſſive. But this was quickly damped by the cruel diſappointment of thoſe ſanguine hopes which had animated them amidſt ſo many hardſhips and dangers. Inſtead of the inexhauſtible wealth which they expected from becoming maſters of Montezuma's treaſures, and the ornaments of ſo many temples, their rapaciousneſs could collect only an inconſiderable booty amidſt ruins and deſolation (A). Guatimozin, aware of his impending fate, had ordered what remained of the riches amaſſed by his anceſtors to be thrown into the lake. The Indian auxiliaries, while the Spaniards were engaged in conflict with the enemy, had carried off the moſt valuable part of the ſpoil. The ſum to be divided among the conquerors was ſo ſmall, that many of them diſdained to accept of the pittance which fell to their ſhare, and all murmured and exclaimed; ſome againſt Cortes and his confidents, whom they ſuſpected of having ſecretly appropriated to their own uſe a large portion of the riches which ſhould have been brought into the common ſtock; others againſt Guatimozin, whom they accuſed of obſtinacy, in refuſing to diſcover the place where he had hidden his treaſure.

Arguments, intreaties, and promiſes, were employed in order to ſoothe them; but with ſo little effect, that Cortes, from ſolicitude to check this growing ſpirit of diſcontent, gave way to a deed which ſtained the glory of all his great actions. Without regarding the former dignity of Guatimozin, or feeling any reverence for thoſe virtues which he had diſplayed, he ſubjected the unhappy monarch, together with his chief favourite, to torture, in order to force from them a diſcovery of the royal treaſures, which it was ſuppoſed they had concealed. Guatimozin bore whatever the refined cruelty of his tormentors could inflict, with the invincible fortitude of an American warrior. His fellow-ſufferer, overcome by the violence of the anguiſh, turned a dejected eye towards his maſter, which ſeemed to implore his permiſſion to reveal all that he knew. But the high-ſpirited prince, darting on him a look of authority mingled with ſcorn, checked his weakneſs, by aſking, "Am I now repoſing on a bed of flowers?" Overawed by the reproach, he perſevered in his dutiful ſilence, and expired. Cortes, aſhamed of a ſcene ſo horrid, reſcued the royal victim from the hands of his torturers, and prolonged a life reſerved for new indignities and ſufferings. 61 Guatimozin tortured.

The fate of the capital, as both parties had foreſeen, decided that of the empire. The provinces ſubmitted one after another to the conquerors. Small detachments of Spaniards marching through them without interruption, penetrated, in different quarters, to the great Southern Ocean, which, according to the ideas of Columbus, they imagined would open a ſhort as well as eaſy paſſage to the Eaſt Indies, and ſecure to the crown of Caſtile all the envied wealth of thoſe fertile regions; and the active mind of Cortes began already to form ſchemes for attempting this important diſcovery. In his after ſchemes, however, he was diſappointed; but Mexico hath ever ſince remained in the hands of the Spaniards. 62 The Spaniards become maſters of the whole Mexican empire.

Mexico is almoſt entirely ſituated within the torrid zone. The air is exceſſively warm, moiſt, and unwholeſome, on the coaſts of the North Sea. Theſe de- 63 Climate, ſoil, &c. of Mexico.

(A) The gold and ſilver, according to Cortes, amounted only to 120,000 peſos, Relat. 280, A. a ſum far inferior to that which the Spaniards had formerly divided in Mexico.

Mexico. defects of the climate are infinitely less felt on the coasts of the South Sea, and hardly at all in the inland country, which is intersected by a chain of mountains, that are supposed to be a continuation of the Cordeleras.

The quality of the soil has the same variations. The eastern part is low, marshy, overflowed in the rainy seasons, covered with impenetrable forests, and totally uncultivated. The soil on the western side is higher, of a better quality, on which there are many fields, and several houses are built upon it. In the low lands there are districts on which nature has been very liberal; but, like every country situated under the tropics, they abound more in fruits than in corn.

The population of this vast empire is not less various than its soil. Its most distinguished inhabitants are the Spaniards sent hither by the court, to fill the posts of government. They are obliged, like those in the mother-country who aspire to any ecclesiastical, civil, or military employments, to prove that there have been neither heretics, Jews, Mohammedans, nor any persons in their family who have been called before the inquisition for four generations. Merchants who are desirous of going to Mexico, as well as to other parts of America, without becoming colonists, are compelled to observe the same forms. They are also obliged to swear that they have 300 palms of merchandise, their own property, in the fleet in which they embark, and that they will not carry their wives with them. On these absurd conditions they become the principal agents of the European commerce with the Indies. Though their charter is only to continue three years, and a little longer for countries more remote, it is of great importance. To them alone belongs the right of selling, as commissioners, the major part of the cargo. If these laws were observed, the merchants stationed in the new world would be confined to dispose of what they have received on their own account.

The predilection which administration has for Spaniards born in Europe, has reduced the Spanish Creoles to acquiesce in subordinate stations. The descendents of the companions of Cortes, and of those who came after them, being constantly excluded from all places of honour or of trust that were any way considerable, have seen the gradual decay of the power that supported their fathers. The habit of being obliged to bear that unjust contempt with which they have been treated, has at last made them become really contemptible. They have totally lost, in the vices which originate from indolence, from the heat of the climate, and from a superfluous enjoyment of all things, that firmness and that sort of pride which have ever characterized their nation. A barbarous luxury, shameful pleasures, and romantic intrigues, have enervated all the vigour of their minds, and superstition hath completed the ruin of their virtues. Blindly devoted to priests too ignorant to enlighten them by their instructions, too depraved to edify them by their example, and too mercenary to attend to both these duties of their function, they have no attachment to any part of their religion but that which enfeebles the mind, and have neglected what might have contributed to rectify their morals.

The Mestees, who constitute the third order of citizens, are held in still greater contempt. It is well known that the court of Madrid, in order to replenish a part of that dreadful vacancy which the avarice and cruelty of the conquerors had occasioned, and to regain the confidence of those who had escaped their fury, encouraged as much as possible the marriage of Spaniards with Indian women. These alliances, which became pretty common throughout all America, were particularly frequent in Mexico, where the women had more understanding and were more agreeable than in other places. The Creoles transferred to this mixed progeny the contemptuous slight they received from the Europeans. Their condition, equivocal at first, in process of time at last was fixed between the whites and the blacks.

These blacks are not very numerous in Mexico. As the natives are more intelligent, more robust, and more industrious, than those of the other colonies, they have hardly introduced any Africans except such as were required either to indulge the caprice, or perform the domestic service, of rich people. These slaves, who are much beloved by their masters, on whom they absolutely depend, who purchased them at an extravagant price, and who make them the ministers of their pleasures, take advantage of the high favour they enjoy, to oppress the Mexicans. They assume over these men, who are called *free*, an ascendant which keeps up an implacable hatred between the two nations. The law has studied to encourage this aversion, by taking effectual measures to prevent all connection between them. Negroes are prohibited from having any amorous correspondence with the Indians; the men, on pain of being mutilated, the women of being severely punished. On all these accounts, the Africans, who in other settlements are enemies to Europeans, are in the Spanish Indies their warm friends.

Authority has no need of this support, at least in Mexico, where population is no longer what it was formerly. The first historians, and those who copied them, have recorded, that the Spaniards found there 10,000,000 of souls. This is supposed to have been the exaggerated account of conquerors, to exalt the magnificence of their triumph: and it was adopted, without examination, with so much the more readiness, as it rendered them the more odious. We need only trace with attention the progress of those ruffians who at first desolated these fine countries, in order to be convinced that they had not succeeded in multiplying men at Mexico and the adjacent parts, but by depopulating the centre of the empire; and that the provinces which are remote from the capital, differed in nothing from the other deserts of South and North-America. It is making a great concession, to allow that the population of Mexico has only been exaggerated one-half: for it does not now much exceed 2,000,000.

64 Mexicans cruelly treated by the Spaniards.

It is generally believed, that the first conquerors massacred the Indians out of wantonness, and that even the priests incited them to these acts of ferocity. Undoubtedly these inhuman soldiers frequently shed blood without even an apparent motive; and certainly their fanatic missionaries did not oppose these barbarities as they ought to have done. This was not, however,

Mexico. degree. The Spaniards are encouraged to profecute the labours which thefe cultures require, from the happy circumftance of their having difcovered iron mines, which were entirely unknown to the Mexicans, as well as fome mines of a kind of copper that is hard enough to ferve for implements of hufbandry. All thefe articles, however, for want of men and induftry, are merely confumed within the country.—There is only the vanilla, indigo, and cochineal, which make part of the trade of Mexico with other nations.

New-MEXICO, fo called becaufe of its being difcovered later than Old-Mexico, a country of America, is bounded on the north by high mountains, beyond which is a country altogether unknown; by Louifiana on the eaft; by New-Spain on the fouth; and on the weft by the gulph of California, and the Rio Colorado; extending, it is faid, above 100 miles from eaft to weft, and about 900 from fouth to north; but the twentieth part of the country within thefe limits is neither cultivated nor inhabited either by Spaniards or Indians. As it lies in the midft of the temperate zone, the climate, in general, is very pleafant; the fummers, though very warm, are neither fultry nor unwholefome; and the winters, though pretty fharp, are far from being infupportable, and, for the moft part, clear and healthy.

The greateft encomiums are lavifhed on the fertility of the foil, the richnefs of the mines, and the variety of valuable commodities produced in this country. It is faid to be beautifully diverfified with fields, meadows, rifing grounds, and rivers; abounding with fruit and timber-trees, turquoifes, emeralds, and other precious ftones, mines of gold and filver, a great variety of wild and tame cattle, fifh, and fowls. Upon the whole, we may fafely affirm, that New-Mexico is among the pleafanteft, richeft, and moft plentiful countries in America, or any other part of the world. There are few great or navigable rivers in it: the moft confiderable are, the Rio Solado and Rio del Norte, which, with feveral fmaller ftreams, fall into the gulph of Mexico. On the coaft of the gulph are divers bays, ports, and creeks, which might be eafily converted into excellent harbours if the Spaniards were poffeffed of any portion of that commercial fpirit which animates the other maritime nations of Europe.

The Spanifh writers tell us, that New-Mexico is inhabited by a great variety of Indian nations or tribes, totally unconnected with each other: but the principal are the Apaches, a brave, warlike, refolute people; fond of liberty, and the inveterate enemies of tyranny and oppreffion. About the clofe of the laft century, thinking themfelves aggrieved by the Spanifh government, they made a general infurrection, and did a great deal of mifchief; but were at laft obliged to fubmit, and have fince been curbed by ftronger garrifons. Moft of the natives are now Chriftians. When the Spaniards firft entered this country, they found the natives well clothed, their lands cultivated, their villages neat, and their houfes built with ftone. Their flocks alfo were numerous, and they lived more comfortably than moft of the other favages of America. As to religion, they were idolaters, and worfhipped the fun and moon; but whether they offered human facrifices, we are not fufficiently informed.

As to the number of the provinces of this country, we can advance nothing certain; fome writers making them only five, others 15, 18, 20, and 25; but adding no defcription, either of them or the towns contained in them, excepting the capital, Santa Fé, which we are told, ftands near the fource of the Rio del Norte, in 36° of north latitude, and about 130 leagues from the gulph: that it is a well-built handfome, rich town; and the feat of a bifhop, fuffragan of Mexico, as well as of the governor of the province, who is fubordinate to the viceroy of Mexico, or New-Spain.

Mezeray. MEZERAY (Francis Eudes de), an eminent French hiftorian, the fon of Ifaac Eudes a furgeon, was born at Rye, in Lower Normandy, in 1610; and took the furname of *Mezeray*, from a hamlet near Rye. Having performed his ftudies at Caen, he difcovered a ftrong inclination to poetry; but going to Paris, he, by the advice of one of his friends, applied himfelf to the ftudy of politics and hiftory, and procured the place of commiffary at war, which he held for two campaigns. He then fhut himfelf up in the college of St Barbe, in the midft of books and manufcripts; and, in 1643, publifhed the firft volume of the Hiftory of France, in folio; and fome years after, the other two volumes. Mezeray in that work furpaffed all who had written the hiftory of France before him, and was rewarded by the king with a penfion of 4000 livres. In 1668, he publifhed an Abridgment of his Hiftory of France, in three volumes 4to. which was well received by the public: but as he inferted in that work the origin of moft of the taxes, with very free reflections, Mr Colbert complained of it, when Mezeray promifed to correct what he had done in a fecond edition; but thofe corrections being only palliations, the minifter caufed half of his penfion to be fuppreffed. Mezeray complained of this in very fevere terms; when he obtained no other anfwer than the fuppreffion of the other half. Vexed at this treatment, he refolved to write on fubjects that could not expofe him to fuch difappointments; and compofed his treatife on the origin of the French, which did him much honour. He was elected perpetual fecretary to the French academy; and died in 1683. He is faid to have been a man extremely negligent in his perfon; and fo carelefs in his drefs, that he might have paffed for a beggar, rather than for what he was. He was actually feized one morning by the *archers des pauvres*, or parifh-officers; which miftake was fo far from provoking him, that he was highly diverted with it, and told them, that "he was not able to walk on foot, but that as foon as a new wheel was put to his chariot, he would attend them wherever they thought proper." He ufed to ftudy and write by candle-light, even at noon-day in fummer; and, as if there had been no fun in the world, always waited upon his company to the door with a candle in his hand. With regard to religion, he affected Pyrrhonifm; which however was not, it feems, fo much in his heart as in his mouth. This appeared from his laft ficknefs: for having fent for thofe friends who had been the moft ufual witneffes of his licentious talk about religion, he made a fort of recantation, which he concluded with defiring them "to forget what he might formerly have faid upon the fubject of religion, and to remember, that Mezeray dying was a

a better believer than Mezeray in health." Befides his hiftory, he alfo wrote, 1. A continuation of the hiftory of the Turks. 2. A French tranflation of John de Sarifbury's Latin treatife on the vanities of the court. 3. There are attributed to him feveral fatires againft the government; and in particular, thofe that bear the name of *Sandricourt*.

MEZIERS, a ftrong town of France, in Champagne, with a citadel. It was befieged with a powerful army by Charles V. who was obliged to raife the fiege in 1521. It is feated on the river Meafe, partly upon a hill, and partly in a valley, in E. Long. 3. 48. N. Lat. 49. 46.

MEZIRIAC (Claude Gafpar Backet Sieur de), one of the moft ingenious men of the 17th century, was born at Breffe, of an ancient and noble family. He was a good poet in French, Italian, and Latin; an excellent grammarian, a great Greek fcholar, and an admirable critic. He was well verfed in the controverfies, both in philofophy and religion; and was deeply fkilled in algebra and geometry, of which laft he gave proof by publifhing the fix books of Diophantes, enriched with a very able Commentary and Notes. In his youth he fpent a confiderable time at Paris and at Rome: at which laft place he wrote a fmall collection of Italian poems, in competition with Vaugelas, who was there at the fame time; among which there are imitations of the moft beautiful fimilies contained in the eight firft books of the Æneid. He alfo tranflated Ovid's Epiftles; a great part of which he illuftrated with very curious Commentaries of his own. While he was at Paris, they talked of making him preceptor of Lewis XIII.: upon which he left the court in great hafte, and afterwards declared that he had never felt fo much pain upon any occafion of his life; for he feemed to have already upon his fhoulders the important weight of the whole kingdom. He undertook the tranflation of all Plutarch's works, with notes; which he had brought nearly to a conclufion, when he died at Bourg, in Breffe, anno 1638, at 45 years of age. He left behind him feveral finifhed works, that were not printed.

MEZZOTINTO, a particular manner of reprefenting figures on copper, fo as to form prints in imitation of painting in Indian ink.

The manner of making mezzotintos is very different from all other kinds of engraving and etching; fince, inftead of forming the figures with lines and fcratches made with the point of a graver, or by means of aquafortis, they are wholly formed by fcraping and burnifhing. Mezzotintos are made in the following manner: Take a well-polifhed copperplate, and beginning at the corner, rake or furrow the furface all over with a knife or inftrument made for the purpofe, firft one way, and then the other, till the whole is of a regular roughnefs, without the leaft fmooth part to be feen; in which ftate, if a paper was to be worked off from it at the copper-plate prefs, it would be all over black. When this is done, the plate is rubbed over with charcoal, black chalk, or black lead, and then the defign is drawn with white chalk; after which the out-lines are traced out, and the plate finifhed by fcraping off the roughnefs, fo as to leave the figure on the plate. The outlines and deepeft fhades are not fcraped at all; the next fhades are fcraped but little, the next more; and fo on, till the fhades gradually falling off, leave the paper white, in which places the plate is neatly burnifhed.

By an artful difpofition of the fhades and different parts of a figure on different plates, mezzotintos have been printed in colours, fo as nearly to refemble very beautiful paintings.

MIASMA, among phyficians, a particular kind of effluvia, by which certain fevers, particularly intermittents, are produced. See MEDICINE, n° 139.

MICA, GLIMMER, in natural hiftory, a genus of talcs. See TALC.

MICAH, or *The Book of* MICAH, a canonical book of the Old Teftament, written by the prophet Micah, who is the feventh of the twelve leffer prophets. He is cited by Jeremiah, and prophefied in the days of Jotham, Ahaz, and Hezekiah. He cenfures the reigning vices of Jerufalem and Samaria, and denounces the judgments of God againft both kingdoms. He likewife foretells the confufion of the enemies of the Jews, the coming of the Meffiah, and the glorious fuccefs of his church.

MICHAEL (Angelo Buonaruoti). See ANGELO.

MICHAEL (Angelo da Caravaggia). See ANGELO, and CARAVAGGIO.

Mount MICHAEL, one of the moft celebrated ftate-prifons of France, lies about 20 miles from Granville. It is a rock fituated in the middle of the bay of Avranches; and is only acceffible at low water. Nature has completely fortified one fide, by its craggy and almoft perpendicular defcent, which renders it impracticable to mount it by any addrefs or courage, however confummate. The other parts are furrounded by walls fenced with femilunar towers after the Gothic manner; but fufficiently ftrong, together with the advantages of its fituation, to render it impregnable to any attack. At the foot of the mountain begins a ftreet or town, which winds round its bafe to a confiderable height. Above are chambers where ftate-prifoners are kept, and where there are other buildings intended for refidence. On the fummit is erected the abbey itfelf, occupying a prodigious fpace of ground, and of a ftrength and folidity equal to its enormous fize; fince it has for many centuries withftood all the injuries of the weather, to which it is fo much expofed. In an apartment, called the *Sale de Chavalerie*, the knights of St Michael ufed to meet in folemn convocation on important occafions. They were the defenders and guardians of this mountain and abbey, as thofe of the temple, and of St John of Jerufalem, were of the holy fepulchre. The hall in which they met is very fpacious, but rude and barbarous. At one end is a painting of the archangel, the patron of their order; and in this hall Lewis XI. firft inftituted and invefted with the infignia of knighthood the chevaliers of the crofs of St Michael. There is a miferable dark apartment, or rather dungeon, in which many eminent perfons were formerly confined. In the middle of it is a cage, compofed of prodigious bars of wood; and the wicket which gives entrance into it is 10 or 12 inches in thicknefs. The infide of it comprifes about 12 or 14 feet fquare, and it is nearly 20 in height. Towards the latter end of the laft century, a certain newfwriter in Holland, who had prefumed to print fome very fevere and farcaftic reflections on Madame de Main-

Michael. Maintenon, was confined in this place. Some months after his publication, he was induced, by a perfon fent exprefsly for that purpofe, to make a tour into French Flanders. The moment he had quitted the Dutch territories, he was put under arreft; and immediately, by his majefty's exprefs command, conducted to Mount Michael, where he was fhut up in this cage. Here he lived upwards of 23 years; and here he at length expired. During the long nights of winter, no candle or fire was allowed him. He was not permitted to have any book. He faw no human face, except the goaler; who came once every day to prefent him, through a hole in the wicket, with his little portion of bread and wine. No inftrument was given him with which he could deftroy himfelf: but he found means at length to draw out a nail from the wood, with which he engraved, or cut on the bars of his cage, certain fleurs de lis and armorial bearings, which formed his only employment and recreation. They are very curioufly performed, confidering the rudenefs of his tool.

The fubterraneous chambers in this mountain are faid to be fo numerous, that the jailors themfelves do not know them. There are certain dungeons called *oubliettes*, into which they were accuftomed anciently to let down malefactors guilty of very heinous crimes: they provided them with a loaf of bread and a bottle of wine, and then they were totally forgotten, and left to perifh by hunger in the dark vaults of the rock. This punifhment, however, has not been inflicted by any king in the laft or prefent century.

Here alfo is a remarkable chamber, in one corner of which is a kind of window; between this and the wall of the building is a very deep fpace, of near 100 feet perpendicular, at the bottom of which is another window opening to the fea. It is called the *Hole of Montgomeri;* and the hiftory of it is as follows: In the year 1559, Henry II. king of France was unfortunately killed at a tournament by the count de Montgomeri ‡. He was a Huguenot; and having efcaped the maffacre of Paris, made head againft the royal forces in Normandy, fupported by queen Elizabeth with arms and money. Being driven from his fortreffes in thefe parts, he retired to a rock called the *Tombelaine*. This is another fimilar to Mount Michael; only three quarters of a league from it, and of nearly equal dimenfions. At that time there was a caftle upon it, which hath fince been demolifhed, and of which fcarce any veftiges now remain. From this fortrefs, acceffible only at low-water, he continually made excurfions, and annoyed the enemy, who never dared to attack him. He coined money, laid all the adjacent country under contribution, and rendered himfelf univerfally dreaded. Defirous, however, to furprife Mount Michael, he found means to engage one of the monks refident in the abbey; who promifed to give him the fignal for his enterprife by difplaying a handkerchief. The monk having made the fignal, betrayed him, and armed all his affociates, who waited Montgomeri's arrival. The chieftain came, attended by 50 chofen foldiers, all defperate, and capable of any attempt. They croffed the fand; and having placed their fcaling-ladders, mounted one by one. As they came to the top, they were difpatched, each in turn, without noife. Montgomeri, who followed laft, difcovered the perfidy, and efcaped with only two of his men, with whom he regained the Tombelaine. They preferve with great care the ladders and grappling irons ufed on this occafion. The count was at laft befieged and taken prifoner, by the marefhal de Matignon, in 1574, at Domfront in Normandy; and Catharine de Medicis, who hated him for having been, though innocently, the caufe of her hufband's death, caufed him to be immediately executed.

‡ See *France*, nº 80.

The church of Mount Michael is a great curiofity. It ftands on nine pillars of moft enormous dimenfions, built on the folid rock. Each of them appear to be about 25 feet in circumference: befides thefe, there are two others much inferior in fize, on which the centre of the church refts, and over which is the tower. The following is the legendary account of the origin of this church: In the reign of Childebert II. there was a bifhop of Avranches named *St Aubert*. To this holy man the archangel Michael was pleafed to appear one night, and ordered him to go to this rock to build a church. St Aubert treated this as a dream; upon which the angel appeared a fecond time; and being ftill difobeyed, he returned a third time; when, by way of imprinting his command upon the faint's memory, he made a hole in his fkull, by touching it with his thumb. The fkull is ftill preferved in the treafury of the church. It is inclofed in a little fhrine of gold, and a cryftal, which opens over the orifice, admits the gratification of curiofity by the minuteft examination of it. The hole is of a fize and fhape proportionable to the thumb faid to have produced it; but it is impoffible to determine whether it has been really made by a knife, or any other way. It is not to be fuppofed that the faint would forget fuch a fenfible mark of the angel's difpleafure; he therefore immediately repaired to the rock, and constructed a fmall church, as he had been commanded. Here, however, true hiftory fupplies the place of fable; and informs us, that it was in 966 when Richard the fecond duke of Normandy began to build the abbey. It was completed about the year 1070, under William the Conqueror, though many other additions were made by fucceeding abbots.

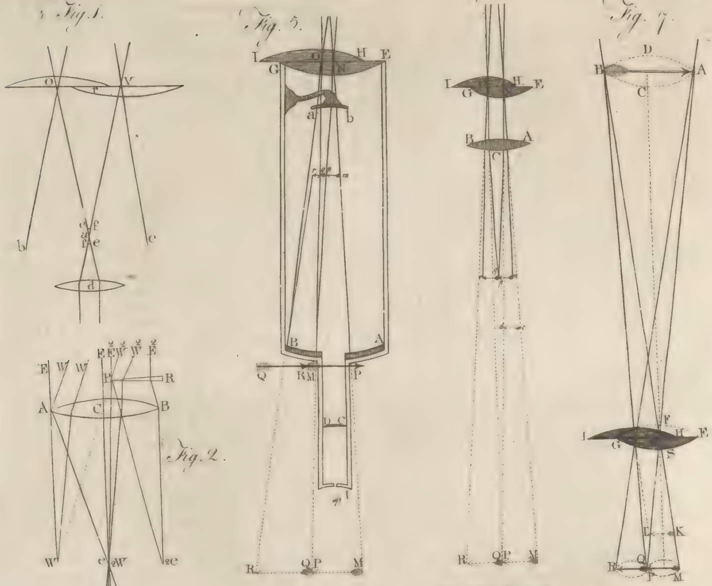
In the treafury of the church are innumerable other relics; among which fome few have a real and intrinfic value. There is a fine head of Charles VI. of France, cut in a cryftal, and the reprefentation of a cockle-fhell in gold, weighing many pounds, given by Richard II. duke of Normandy when he founded the abbey. There is an arm faid to belong to *St Richard* king of England; but who this faint was, muft be very difficult to determine.

MICHAELMAS, or *Feaft of St* MICHAEL *and all Angels*, a feftival of the Chriftian church, obferved on the 29th of September.

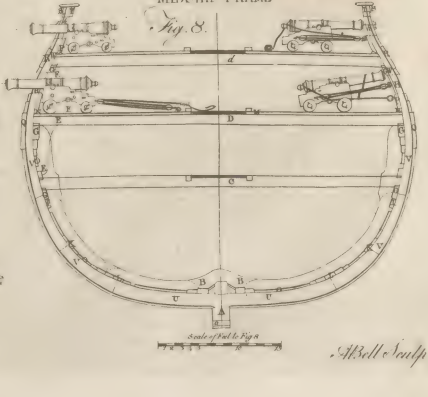
The Scripture account of Michael is, That he was an archangel, who prefided over the Jewifh nation, as other angels did over the Gentile world, as is evident of the kingdoms of Perfia and Greece; that he had an army of angels under his command; that he fought with the Dragon, or Satan and his angels; and that, contending with the devil, he difputed about the body of Mofes.

As to the combat between Michael and the Dragon, fome authors underftand it literally, and think it means the expulfion of certain rebellious angels, with their

MICROMETERS.



MIDSHIP FRAME



A.Bell Sculp!

their head or leader, from the presence of God. Others take it in a figurative sense; and refer it, either to the contest that happened at Rome between St Peter and Simon Magus, in which the apostle prevailed over the magician; or to those violent persecutions, under which the church laboured for 300 years, and which happily ceased when the powers of the world became Christian.

The contest about the body of Moses is likewise taken both literally and figuratively. Those who understand it literally, are of opinion, that Michael, by the order of God, hid the body of Moses after his death, and that the devil endeavoured to discover it, as a fit means to entice the people to idolatry by a superstitious worship of his relics. But this dispute is figuratively understood to be a controversy about rebuilding the temple, and restoring the service of God among the Jews at Jerusalem, the Jewish church being fitly enough styled the *body of Moses*. It is thought by some, that this story of the contest between Michael and the devil was taken by St Jude out of an apocryphal book, called the *Assumption of Moses*.

MICROCOSM, a Greek term signifying the *little world*; used by some for man, as being supposed an epitome of the universe or great world.

MICROGRAPHY, the description of objects too minute to be viewed without the assistance of a microscope. See Microscopic *Objects*.

MICROMETER, an instrument, by the help of which the apparent magnitudes of objects viewed thro' telescopes or microscopes are measured with great exactness.

The first micrometers were only mechanical contrivances for measuring the image of an object in the focus of the object-glass. Before these contrivances were thought of, astronomers were accustomed to measure the field of view in each of their telescopes, by observing how much of the moon they could see through it, the semidiameter being reckoned at 15 or 16 minutes; and other distances were estimated by the eye, comparing them with the field of view. Mr Gascoigne, an English gentleman, however, fell upon a much more exact method, and had a treatise on Optics prepared for the press; but he was killed during the civil wars, in the service of Charles I. and his manuscript was never found. His instrument, however, fell into the hands of Mr R. Townly, who says, that by the help of it he could mark above 40,000 divisions in a foot.

Mr Gascoigne's instrument being shewn to Dr Hooke, he gave a drawing and description of it, and proposed several improvements in it, which may be seen in *Phil. Trans.* abr. Vol. I. p. 217. Mr Gascoigne divided the image of an object, in the focus of the object-glass, by the approach of two pieces of metal, ground to a very fine edge, in the place of which Dr Hooke would substitute two fine hairs stretched parallel to one another. Two other methods of Dr Hooke's, different from this, are are described in his Posthumous Works, p. 497, 498. An account of several curious observations that Mr Gascoigne made by the help of his micrometer, particularly in the mensuration of the diameters of the moon and other planets, may be seen in the Phil. Trans. Vol. XLVIII. p. 190.

Mr Huygens, as appears by his System of Saturn, published in 1659, used to measure the apparent diameters of the planets, or any small angles, by first measuring the quantity of the field of view in his telescope; which, he says, is best done by observing the time which a star takes up in passing over it, and then preparing two or three long and slender brass plates, of various breadths, the sides of which were very straight, and converging to a small angle. In making use of these pieces of brass, he made them slide in two slits, that were made in the sides of the tube, opposite to the place of the image, and observed in what place it just covered the diameter of any planet, or any small distance that he wanted to measure. It was observed, however, by Sir Isaac Newton, that the diameters of planets, measured in this manner, will be larger than they should be, as all lucid objects appear to be, when they are viewed upon dark ones.

In the Ephemerides of the Marquis of Malvasia, published in 1662, it appears that he had a method of measuring small distances between fixed stars, and the diameters of the planets, and also of taking accurate draughts of the spots of the moon; and this was by a net of silver wire, fixed in the common focus of the object and eye-glass. He also contrived to make one of two stars to pass along the threads of this net, by turning it, or the telescope, as much as was necessary for that purpose; and he counted, by a pendulum-clock, beating seconds, the time that elapsed in its passage from one wire to another, which gave him the number of the minutes and seconds of a degree contained between the intervals of the wires of his net, with respect to the focal length of his telescope.

In 1666, Messrs Auzout and Picard published a description of a micrometer, which was nearly the same with that of the Marquis of Malvasia, excepting the method of dividing it, which they performed with more exactness by a screw. In some cases they used threads of silk, as being finer than silver wires. Dechales also recommends a micrometer consisting of fine wires, or silken threads, the distances of which were exactly known, disposed in the form of a net, as peculiarly convenient for taking a map of the moon.

M. de la Hire says, that there is no method more simple or commodious for observing the digits of an eclipse than a net in the focus of the telescope. These, he says, were generally made of silken threads; and that for this particular purpose six concentric circles had also been made use of, drawn upon oiled paper; but he advises to draw the circles on very thin pieces of glass with the point of a diamond. He also gives several particular directions to assist persons in the use of them. In another memoir he shews a method of making use of the same net for all eclipses, by using a telescope with two object-glasses, and placing them at different distances from one another.

M. Cassini invented a very ingenious method of ascertaining the right ascensions and declinations of stars, by fixing four cross hairs in the focus of the telescope, and turning it about its axis, so as to make them move in a line parallel to one of them. The difficulty there was in accomplishing this was entirely removed by a mechanical contrivance of Dr Bradley.

M. Lewenhoek's method of estimating the size of small objects was by comparing them with grains of sand, of which 100 placed in a line took up an inch. These grains he laid on the same plate with his ob-

Micrometer

jects, and viewed them at the fame time. Dr Jurin's method was fimilar to this of M. Lewenhoek; for he found the diameter of a piece of fine filver-wire, by wrapping it as clofe as he could about a pin, and obferving how many rings made an inch. For he ufed this wire in the fame manner as Lewenhoek ufed his fand.

Mr Martin, in his Optics, recommends fuch a micrometer to a microfcope as had been applied to telefcopes; for he advifes to draw a number of parallel lines on a piece of glafs, with the fine point of a diamond, at the diftance of $\frac{1}{40}$ of an inch from one another, and to place it in the focus of the eye-glafs. By this method Dr Smith contrived to take the exact draught of objects viewed by a double microfcope. For he advifes to get a lattice, made with fmall filver wires or fmall fquares, drawn upon a plain glafs by the ftrokes of a diamond, and to put it into the place of the image formed by the object-glafs. Then by transferring the parts of the object, feen in the fquares of the glafs or lattice, upon fimilar correfponding fquares, drawn on paper, the picture may be exactly taken. Mr Martin alfo introduced into compound mifcrofcopes another micrometer, confifting of a fcrew.

Dr Hooke ufed to look upon the magnified object with one eye, while, at the fame time, he viewed other objects placed at the fame diftance with the other eye. In this manner he was able, by the help of a ruler, divided into inches and fmall parts, and laid on the pedeftal of the microfcope, to caft, as it were, the magnified appearance of the object upon the ruler, and thereby exactly to meafure the diameter which it appeared to have through the glafs; which being compared with the diameter as it appeared to the naked eye, eafily fhewed the degree in which it was magnified. This, fays Mr Baker, is a ready and good method for many objects; and he declares, from his own experience, that a little practice will render it exceedingly eafy and pleafant.

We are obliged to Dr Hooke for an excellent method of viewing the fun without injuring our eyes. For this purpofe he contrived that the rays fhould be reflected from one plane to another, till it was fo much weakened that the eye might receive it with great fafety and pleafure. This method is much preferable to that of looking at the fun through a fmoky or coloured glafs, which gives it a red and difagreeable hue. His difcourfe on this fubject was read before the Royal Society June 28 1675.

Thefe micrometers, however, have feveral confiderable defects. In particular, it is not eafy to meafure with them objects that are in motion, or thofe which are too large to come within the field of view; fo that the diameters of the fun and moon cannot well be meafured with them to any great degree of exactnefs. Another method was found of meafuring the apparent magnitude of the object, free from the inconveniencies above mentioned, by means of a telefcope furnifhed with two object-glaffes. This ingenious method was hit upon about the fame time both by Mr Servington Sauvery and the celebrated M. Bouguer.

In this inftrument, both object-glaffes are of equal focal diftance, and placed one of them by the fide of the other; fo that the fame eye-glafs may ferve for them both. By this means two diftinct images of an object are formed in the focus of the eye-glafs; and fince the diftance of thefe images depends upon the diftance at which the two object-glaffes are placed from one another, it may be meafured with great accuracy. Nor is it neceffary that the whole difc of the fun or moon come within the field of view; fince, if the images of a fmall part of the difc be formed by each object-glafs, the whole diameter may eafily be computed, by their pofition with refpect to one another. For if the object be large, the images will approach towards, or perhaps even ly over one another. And the object-glaffes being moveable, the two images may always be brought exactly to touch one another, and the diameter may be computed from the known diftance of the centres of the two glaffes.

Another advantage attending this inftrument is, that by having a common micrometer in the focus of the eye-glafs, when the two images of the fun or moon are made in part to cover one another, that part which is common to both the images may be meafured with great exactnefs, as being viewed upon a ground that is only one half lefs luminous than itfelf; whereas, in general, the heavenly bodies are viewed upon a dark ground, and on that account are imagined to be larger than they really are. By a fmall addition to this inftrument, provided it be of a moderate length, M. Bouguer thought it very poffible to meafure angles of three or four degrees; which is of particular confequence in taking the diftance of ftars from the moon.

Mr Sauvery's paper containing a very particular defcription of his conftruction of this inftrument was read at the Royal Society October 27. 1743, and M. Bouguer's account of his inftrument which he called an *heliometer* is contained in the Memoirs of the Royal Academy of Sciences for the year 1748, p. 15.

A very great improvement was made in this kind of micrometer by Mr Dollond; for, inftead of two complete object-glaffes, he ufed only one, cut into two equal parts, one of them fliding by the other. Each half of this object-glafs will give a feparate and diftinct image; and as the diftance at which their centres are placed from one another may be exactly afcertained, the fame ufes may be made of them as of two entire object-glaffes, and the application of them is much more commodious.

But the ground or reafon of this new micrometer, as applied to the refractory or reflecting telefcope, may be illuftrated by figures, as follows:

Let ABCD reprefent any very diftant object, as the fun, &c. and AB its diameter; alfo let EFGS reprefent the object-glafs confifting of two fegments EFG and ESG divided through the centre N in the right line EG. The angle under which it appears at the end of the telefcope will be ANB equal to the angle KNL, under which the image KL is contained. Now, fuppofe the moveable fegment EFG were by a mechanical contrivance drawn off to the pofition HI, the diftance of their centres would be NO; and the two lines AN and BO paffing through the centres N, O, of the fegments, if produced, meet at the focus in L; and fince BL and BK do alfo pafs through the centres N and O, and the object being at an indefinitely great diftance, the line OL will be parallel

Plate CLXXV. fig. 7.

to

Micrometer to NK, and consequently the angle NLO is equal to the angle KNL or ANB; that is to say, *the angle under which the object appears from the end of the telescope (or to the naked eye), is equal to the angle under which the distance between the two centres of the segments appear from the solar focus of the telescope.*

And this will be the case in every distance of an object: for supposing the object AB were at some near distance from the telescope, and subtended the same angle ANB, the only consequence would be, that its image would be formed at a greater distance from the glass, suppose at MP: it would still be contained under the same angle MNP, equal to NLO, as before, upon the supposition that the segment HI and BO produced meets AP in the point P; that is to say, suppose that the segment HI is in such position that the moveable image QR formed by it, exactly coincides with the fixed image MP, formed by the segment ESG.

Concerning this vitreous micrometer we may farther observe, that its great excellency consists in this, that it depends solely in measuring the distance of the centres of the two segments, not only when applied alone at the end of a telescope, but even in conjunction with the object-glass of any common telescope; Fig. 6. for, let EG and HI represent the two segments, as before, of a glass whose focal distance is very long, suppose, for instance, 50 feet; then, at a small distance from it, let AB represent the object-glass of a common long telescope, whose focal distance of parallel rays is C *d*, or its focus of very distant objects *d c*. Then this glass, combined with the foregoing segments, will have its focus shortened, and the common focus of both will be in point *q*. Then because the triangles RCQ and PNM are similar to the triangles *r* O *q* and *p* N *m* respectively; therefore the images RQ and PM will be similar, and alike posited to the two small images *r q* and *p m*; and therefore when these two images are in contact in the focus of the semi-lenses, they will likewise be in contact in the shortened compound focus. And as the centres N and O of the two semi-lenses GE and IH are separated farther from, or brought nearer to, each other, the images in either focus will be moved in similar manner; and when the centres N and O coincide, the images in each focus respectively will also coincide, or become one entire image; the difference in every case being only as to large and small, greater or lesser distance. Consequently, in the micrometer by which those two semi-lenses are moved by each other, the same turns of the screw which measures the angle OPN, and which brings the images into an exact contact in the single focus at Q, will be necessary for the same purpose in the compound focus also; so that by this means we have an opportunity of measuring the said angle OPQ, without being obliged to have so great and so unmanageable a length of the telescope.

However, the larger the focal distance of the lens AB is, the more distinct the contact of the images will appear; and because this is the point on which the whole perfection of this micrometer depends, it will be likewise necessary to have it so contrived, when applied to a telescope, that the centres NO may be equally distant from the axis of the telescope or centre of the aperture on either side; because, in this case, Micrometer the point of contact in the two images will be just in the centre of the focus, and therefore the most distinct that it possibly can be.

But the application of this micrometer to refracting telescopes will be less convenient than when it is applied to a reflecting telescope; for if it be placed on the open end of the reflecting telescope, then will the rays that tend to form the larger images RQ and PM be incident upon the larger speculum Fig. 5. AB, and from thence reflected to a compound focus, where the similar images *r q* and *p m* will be formed as before; the rays proceeding from these two images to the smaller speculum *a b*, will be reflected back through the hole of the larger, to form the images QR and PM, which likewise will still be in contact in the focus of the eye-glass DC, where it will be distinctly perceived by the eye at I. This contact will likewise be shewn in the focus of the eye-glass, if the centres O and N are properly disposed, as before-mentioned.

From what has been said, the general rationale of this micrometer will evidently appear; but one thing must not pass unregarded in an affair of such moment and consequence as the measuring these small angles in the science of astronomy. It has been customary to suppose, that the focus of a lens, or the local distance of rays parallel to its axis, is equal to the radius in a double and equally convex lens. But this is too great an error not to be noticed here; for in different sorts of glass there is found a different refractive power, and the focus of parallel rays is at a different distance in each; but this distance in no sort of glass is equal to the radius, but falls short of it more or less. Now the foregoing demonstration regards the radius, and not the focal distance of parallel rays.

With regard to the planets, as Jupiter is the largest of all, and subtends an angle to the eye of 3′ 12″, the diameter of his image in the focus of a 50 foot glass will be about half an inch; and that will be the utmost distance to which the centres of the segments will be required to be separated for measuring the apparent diameters of the planets.

But for a heliometer, the diameter of the sun, being near 10 times as great as that of Jupiter, will require the centres of the segments in a glass of 40 or 50 feet focus to be removed from each other at least to the distance of four or five inches; and to take in the whole system of Jupiter's moons, the distance of the centres will be required much larger; and therefore, for such purposes, the segments of glasses of a less focal length must be used.

But, valuable as the object-glass micrometer undoubtedly is, some difficulties have been found in the use of it, owing to the alterations in the focus of the eye, which are apt to cause it to give different measures of the same angle at different times. For instance, in measuring the sun's diameter, the axes of the pencils of rays, which come through the two segments of the object-glass from contrary limbs of the sun, crossing one another at the focus of the telescope under an angle equal to that of the sun's diameter, the union of the limbs of the two images of the sun cannot appear perfect unless the eye be disposed to see

fee objects diftinctly which are placed at the point of interfection. But if the eye be difpofed to fee objects diftinctly, which are placed nearer the object-glafs than the interfection is, the two limbs will appear feparated by the interval of the axes of the pencils in that place; and if the eye be difpofed to fee objects diftinctly, which are placed farther from the object-glafs than the interfection is, the two limbs will appear to encroach upon each other by the diftance of the axes of the pencils, after their croffing, taken at that place.

Fig. 1. To explain this, let OV reprefent the centres of the two femicircular glaffes of the object-glafs micromemeter, feparated to the diftance OV from each other, fubtending the angle O*a*V, equal to the fun's diameter, at the point *a*, which is the common focus of the two pencils of rays having O*a* and V*a* for their axes, namely, thofe proceeding from contrary fides of the fun, and paffing through the contrary femi-circles; and let *d* be the eye-glafs. It is evident, that if *d* be properly placed to give diftinct vifion of objects placed at the point *a*, the rays O*a*, V*a*, as well as all the other rays belonging to thofe pencils, will be collected into one point upon the retina of the eye; and confequently, the two oppofite limbs of the two images of the fun will feem to coincide, and the two images of the fun to touch one another externally. But if the ftate of the eye fhould alter, the place of the eye-glafs remaining the fame, the eye will be no longer difpofed to fee the image formed at the point *a* diftinctly, but to fee an object placed at e*f*, nearer to or farther from the object-glafs diftinctly; and therefore an image will be formed on the retina exactly fimilar to the fomewhat confufed image formed by the rays on a plane perpendicular to their courfe at e*f*. Confequently, as the two cones of folar rays, *b*O *a*, *c*V*a*, formed by the two femi-circles, are feparated or encroach upon one another at this point of the axis by the diftance e*f*, the two images of the fun will not feem to touch one another externally, but to feparate or to encroach upon one another by the interval e*f*. The error hereby introduced into the meafure of the fun's diameter will be the angle e*rf*, fubtended by e*f* at *r* the middle point between O and V, which is to c*af* or O*a*V, the fun's apparent diameter, as ee to e*r*, or even to *ar*, on account of the fmallnefs of *a*e with refpect to *ar*.

Thefe confiderations concerning the caufe of a principal error that has been found in the object-glafs micrometer led to an inquiry, whether fome method might not be found of producing two diftinct reprefentations of the fun, or any other object, which fhould have the axes of the pencils of rays, by which they are formed, diverging from one and the fame point, or nearly fo: and it occurred to Mr Mafkelyne, that this might be done by the refraction of a prifm placed to receive part of the rays proceeding from the object, either before or after their refraction through the object-glafs of a telefcope. If the prifm be placed without the object-glafs, the rays that are refracted thro' it will make an angle with the rays that pafs befide it equal to the refraction of the prifm; and this angle will not be altered by the refraction of the object-glafs afterwards. Confequently, two images of an object will be reprefented, and the prifm fo applied will enable us to meafure the apparent diameter of any object, or any other angular diftance which is equal to the refraction of the prifm. But if the prifm be placed within the object-glafs, that is to fay, between the object-glafs and eye-glafs, the angle meafured by the inftrument will vary according to the diftance of the prifm from the focus of the object-glafs, bearing the fame ratio to the refraction of the prifm, as the diftance of the prifm from the focus bears to the focal length of the object-glafs.

Let ACB (fig. 2.) reprefent the object-glafs and *d* the eye-glafs of a telefcope, and PR a prifm placed to intercept part of the rays coming from an object, fuppofe the fun, before they fall on the object-glafs. The rays EE proceeding from the eaftern limb of the fun, and refracted through the object-glafs ACB without paffing through the prifm, will form the correfponding point of the fun's image at e; and the rays WW proceeding in like manner from the weftern limb of the fun will be refracted to form the correfponding point of the fun's image at W. But the rays 2E, 2E, 2W, 2W, proceeding in like manner from the eaftern and weftern limbs of the fun, and falling on the prifm PR, and thence refracted to the object-glafs ACB, will, after refraction through it, form the correfpondent points of the fun's image at 2e, 2W. Let the refraction of the prifm be equal to the fun's apparent diameter: in this cafe, at whatever diftance the prifm be placed beyond the object-glafs, the two images of the fun We, 2W 2e, will touch one another externally at the point e2W; for the rays 2W, 2W, proceeding from the weftern of the fun being inclined to the rays EE proceeding from the eaftern limb in the angle of the fun's apparent diameter, will, after fuffering a refraction in paffing through the prifm equal to the fun's apparent diameter, emerge from the prifm and fall upon the object-glafs parallel to the rays EE, and confequently will have their focus 2W coincident with the focus e of the rays EE; and therefore the two images of the fun We, 2W 2e, will touch one another externally at the point e 2W, and the inftrument will meafure the angle EC2W, and that only.

But if the prifm be placed within the telefcope, the angle meafured by the inftrument will be to the refraction of the prifm as the diftance of the prifm from the focus of the object-glafs is to the focal diftance of the object-glafs: or if two prifms be ufed to form the two images, with their refracting angles placed contrary ways, as reprefented in fig. 3. and 4. the angle meafured will be to the fum of the refractions of the prifm, as the diftance of the prifms from the focus of the object-glafs is to the focal diftance of the object-glafs. For let ACB (fig. 3.) reprefent the object-glafs, and *d* the eye-glafs of a telefcope, and PR, RS, two prifms interpofed between them, with their refracting angles turned contrary ways, and the common fections of their refracting planes touching one another at R. The rays proceeding from an object, fuppofe the fun, will be difpofed, by the refraction of the object-glafs, to form an image of the fun at the focus; but part of them falling on one prifm, and part on the other, will be thereby refracted contrary ways, fo as to form two equal images We, 2W 2e, which, if the refractions of the prifms be of proper quantities, will touch one another externally at the point e 2W.

Let


Plate CLXXVI.
Fig. 1 MUREX. N°. 1.
N°. 2.
N°. 3.
N°. 4.
Fig. 3. MELEAGRIS
or Horned Pheasant
Fig. 5
MYA. N° 1.
N° 2.
N° 3
N° 4
Fig. 2.
MONODON.
Fig. 4. MERGUS or
Round Crested Diver
A. Bell Sculp!

Let ECN be the axis of the pencil of rays EE proceeding from the ſun's eaſtern limb; and WCO the axis of the pencil of rays WW proceeding from the ſun's weſtern limb; and the point N the place where the image of the ſun's eaſtern limb would be formed, and the point O where that of the weſtern limb would be formed, were not the rays diverted from their courſe by the refractions of the priſms. But by this means part of the rays EE, which were proceeding to N, falling on the priſm PR, will be refracted to form an image of the ſun's eaſtern limb at *e*, while others of the rays EE, which fall on the priſm RS, will be refracted to form an image of the ſun's eaſtern limb at 2*e*. In like manner, part of the rays WW, which were proceeding to form an image of the ſun's weſtern limb at O, falling on the priſm RS, will be refracted to form an image of the ſun's weſtern limb at 2W coincident with e, the point of the image correſpondent to the ſun's eaſtern limb; while others of the rays WW, which fall on the priſm PR, will be refracted to form the image of the ſun's weſtern limb at W. The two images We, 2W 2e, are ſuppoſed to touch one another externally at the point e2W. The ray EFR, which belongs to the axis ECN, and is refracted by the priſm PR to e, undergoes the refraction NRe, which (becauſe ſmall angles are proportional to their ſines, and the ſine of NR*e* is equal to the ſine of its ſupplement NRC), is to NCR as NC or C*e* is to NR or R*e*. In like manner, the ray WGR, which belongs to the axis WCO, and is refracted by the priſm RS to 2W or e, undergoes the refraction ORe, which is to OCe as OC or Ce is to RO or Re; therefore, by compoſition, ORN the ſum of the refractions OR*e*, NR*e*, is to OCN the ſum of the angles OC*e*, NC*e*, or the ſun's apparent diameter, as C*e* to R*e*; that is, as the focal diſtance of the object-glaſs to the diſtance of the priſms from the focus of the object-glaſs.

Or let the priſms PR, RS, be placed with their refracting angles P, S, turned from one another as in fig. 4.: the refraction of the priſm PR will transfer the image of the ſun from ON to We, and the refraction of the priſm RS will transfer the image ON to 2W 2e, the two images 2W 2e, We, touching one another externally at the point 2We. Let ECN, WCO, be the axes of the pencils of rays proceeding from the two extreme limbs of the ſun, and N, O, the points where the images of the ſun's eaſtern and weſtern limbs would be formed by the object-glaſs, were it not for the refraction of the priſms; the ray EFR, which belongs to the axis ECN, and is refracted by the priſm RS, to 2e, undergoes the refraction NR2e; and the ray WGR, which belongs to the axis WCO, and is refracted by the priſm PR to W, undergoes the refraction ORW. Now NC2e, part of the angle meaſured, is to NR2e, the refraction of the priſm RS, as RW to CW; and OCW, the other part of the angle meaſured, is to ORW, the refraction of the priſm PR, in the ſame ratio of RW to CW: therefore OCN, the whole angle meaſured, is to ORN, the ſum of the refractions of the two priſms, as RW to CW; that is, as the diſtance of the priſms from the focus of the object-glaſs to the focal diſtance of the object-glaſs.

When the priſms are placed in the manner repreſented in fig. 3. the point e of the image We is illuminated only by the rays which fall on the object-glaſs between A and F, and the point 2W only by the rays which fall on the object-glaſs between B and G. Now the angles CRF, CRG, equal to the refractions of the priſms, being conſtant, the ſpaces FC, CG, will increaſe in proportion as the diſtances RF, RG, increaſe, and the ſpaces AF, GB, diminiſh as much; and therefore the images at the point of mutual contact e2W will be each illuminated by half the rays which fall on the object-glaſs when the priſms are placed cloſe to the object-glaſs, but will be enlightened leſs and leſs the nearer the priſms are brought to the focus of the object-glaſs.

But when the priſms are placed in the manner ſhewn in fig. 4. the images at the point of contact, as the priſms are removed from the object-glaſs towards the eye-glaſs, will be enlightened with more than half the rays that fall on the object-glaſs, and will be moſt enlightened when the priſms are brought to the focus itſelf; for the point 2e of the image 2W 2e will be enlightened by all the rays EE that fall on the object-glaſs between B and B, and the point W of the image W e will be enlightened by all the rays WW which fall on the object-glaſs between A and G. But the difference of the illuminations is not very conſiderable in achromatic teleſcopes, on account of the great aperture of the object-glaſs; as the greateſt ſpace FG is to the focal diſtance of the object-glaſs as the ſum of the ſines of the refractions of the priſms is to the radius.

There is a third way, and perhaps the beſt, of placing the priſm, ſo as to touch one another along their ſides which are at right angles to the common ſections of their refracting planes. In this diſpoſition of the priſms the images will be equally enlightened, namely, each with half the rays which fall on the object-glaſs, wherever the priſms be placed between the object-glaſs and eye-glaſs.

From what has been ſhewn it appears, that this inſtrument, which may be properly called the *priſmatic micrometer*, will meaſure any angle that does not exceed the ſum of the refractions of the priſms, excepting only very ſmall angles, which cannot be taken with it on account of the vaniſhing of the pencils of rays at the juncture of the two priſms near the focus of the object-glaſs; that it will afford a very large ſcale, namely, the whole focal length of the object-glaſs, for the greateſt angle meaſured by it; and that it will never be out of adjuſtment; as the point of the ſcale where the meaſurement begins (or the point of O) anſwers to the focus of the object-glaſs, which is a point for celeſtial objects, and a point very eaſily found for terreſtial objects. All that will be neceſſary to be done, in order to find the value of the ſcale of this micrometer, will be to meaſure accurately the diſtance of the priſms from the focus when the inſtrument is ſet to meaſure the apparent diameter of any object ſubtending a known angle at the centre of the object-glaſs, which may be eaſily found by experiment, as by meaſuring a baſe and the diameter of the object obſerved placed at the end of it, in the manner practiſed with other micrometers: for the angle ſubtended by this object will be to the angle ſubtended by a celeſtial object, or very remote land-object, when the diſtance of the priſms from the principal

cipal focus is the fame as it was found from the actual focus in the terreftrial experiment, as the principal focal diftance of the object-glafs is to the actual focal diftance in the faid experiment.

It will probably be the beft way in practice, inftead of one prifm to ufe two prifms, refracting contrary ways, and fo divide the refraction between them (as reprefented in fig. 3. and 4.). Achromatic prifms, each compofed of two prifms of flint and crown-glafs, placed with their refracting angles contrary ways, will unoubtedly be neceffary for meafuring angles with great precifion by this inftrument: and we can only add with pleafure, that it is found by experiment made with this inftrument, as it was executed by Mr Dollond with achromatic prifms, ground with great care for this trial fometime ago, that the images, after refraction through the prifms, appear very diftinct; and that obfervations of the apparent diameters of objects may be taken in the manner here propofed with eafe and precifion.

Two or more fets of prifms may be adapted to the fame telefcope, to be ufed each in their turn, for the more commodious meafurement of different angles. Thus it may be very convenient to ufe one fet of prifms for meafuring angles not exceeding 36′, and confequently fit for meafuring the diameters of the fun and moon, and the lucid parts and diftances of the cufps in their eclipfes; and another fet of prifms to meafure angles not much exceeding one minute, and confequently fit for meafuring the diameters of all the other planets. This latter fet of prifms will be the more convenient for meafuring fmall angles, on account of a fmall imperfection attending the ufe of this micrometer, as before mentioned; namely, that angles cannot be meafured with it when the prifms approach very near the focus of the object-glafs, the pencils of rays being there loft at the point where the prifms touch one another.

Upon the principles that have been here explained, a prifm placed within the telefcope of an aftronomical inftrument, adjufted by a plumb-line or level, to receive all the rays that pafs through the object-glafs, may conveniently ferve the purpofe of a micrometer, and fuperfede the ufe both of the vernier fcale and the external micrometer; and the inftrument may then be always fet to fome even divifion before the obfervation. Thus the ufe of a telefcopic level may be extended to meafure with great accuracy the horizontal refractions, the depreffion of the horizon of the fea, and fmall altitudes and depreffions of land-objects. Time and experience will doubtlefs fuggeft many other ufeful applications of this inftrument.

But the greateft improvement which the micrometer hath yet received is from Dr Mafkelyne, who hath invented a catoptric one. This, befides the advantage it derives from the principle of reflection, of not being difturbed by the heterogeneity of light, avoids every defect of other micrometers, and can have no aberration, nor any defect which arifes from the imperfection of materials, or of execution, as the extreme fimplicity of its conftruction requires no additional mirrors or glaffes to thofe required for the telefcope: and the feparation of the image being effected by the inclination of the two fpecula, and not depending on the focus of any lens or mirror, any alteration, in the eye of an obferver, cannot affect the angle meafured.

It has, peculiar to itfelf, the advantages of an adjuftment to make the images coincide in a direction perpendicular to that of their motion; and alfo of meafuring the diameter of a planet on both fides the zero, which will appear no inconfiderable advantage to obfervers who know how much eafier it is to afcertain the contact of the external edges of two images than their perfect coincidence. A fhort explanation of the annexed drawings will make the conftruction and the properties of this micrometer obvious.

"I divided (fays Mr Mafkelyne) the fmall fpeculum of a reflecting telefcope, of Caffegrain's conftruction, into two equal parts, by a plane acrofs its centre; and by inclining the halves of the fpeculum to each other on an axis at right angles to the plane that feparated them, I obtained two diftinct images. The fatisfaction I received on the firft trial was checked by the apparent impoffibility of reducing this principle to practice. The angular feparation of the two images in this cafe being half the angular inclination of the two fpecula, it required an index of an unmanageable length to allow the quantity of one fecond of a degree to become vifible. Some time afterwards, on revifing the principle, I confidered, that if both the halves of the mirror turned on their centre of curvature, there could be no alteration in their relative inclination to each other from their motion on this centre; and that any extent of fcale might be obtained, by fixing the centre of motion at a proportional diftance from the common centre of curvature. This will be better underftood from the annexed figure.

"R (fig. 1.) reprefents the fmall fpeculum divided into two equal parts; one of which is fixed on the end of the arm B; the other end of the arm is fixed on a fteel axis X, which croffes the end of the telefcope C. The other half of the mirror R is fixed on the arm D, which arm at the other end terminates in a focket *y*, that turns on the axis, X; both arms are prevented bending by the braces *a a*. G reprefents a double fcrew, having one part *e* cut into double the number of threads in an inch to that of the part *g*: the part *e* having 100 threads in one inch, and the part *g* 50 only. The fcrew *e* works in a nut F in the fide of the telefcope, while the part *g* turns in a nut H, which is attached to the arm B; the ends of the arms B and D, to which the mirrors are fixed, are feparated from each other by the point of the double fcrew preffing againft the ftud *h*, fixed to the arm D, and turning in the nut H on the arm B. The two arms B and D are preffed againft the direction of the double fcrew *eg* by a fpiral fpring within the part *n*, by which means all fhake or play in the nut H, on which the meafure depends, is entirely prevented. Plate CLXXVII.

"From the difference of the threads on the fcrew at *e* and *g*, it is evident, that the progreffive motion of the fcrew through the nut will be half the diftance of the feparation of the two halves of the mirror; and confequently the half mirrors will be moved equally in contrary directions from the axis of the telefcope C.

"The wheel V fixed on the end of the double fcrew has its circumference divided into 100 equal parts, and numbered at every fifth divifion with 5, 10, &c. to 100, and the index I fhews the motion of the fcrew with

Fig. 1.

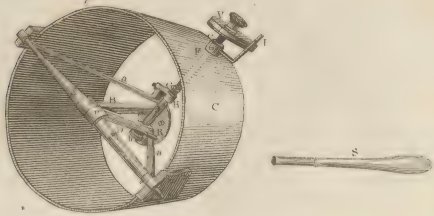


Fig. 2.

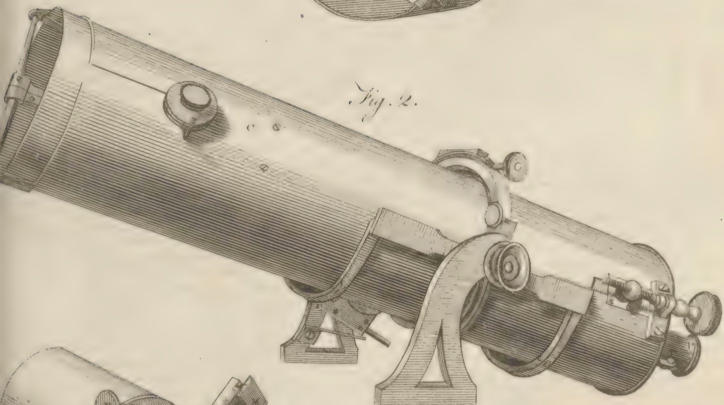


Fig. 3.

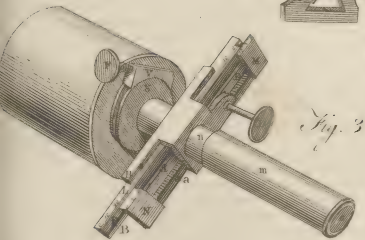
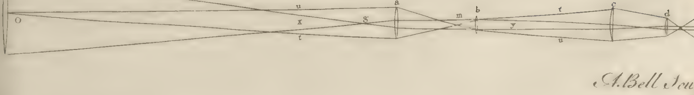


Fig. 4.



A. Bell Sculpt.

with the wheel round its axis, while the number of revolutions of the ſcrew is ſhewn by the diviſions on the ſame index. The ſteel ſcrew at R may be turned by the key S, and ſerves to incline the ſmall mirror at right angles to the direction of its motion. By turning the finger-head T (fig. 2.) the eye-tube P is brought nearer or farther from the ſmall mirror, to adjuſt the teleſcope to diſtinct viſion; and the teleſcope itſelf hath a motion round its axis for the conveniency of meaſuring the diameter of a planet in any direction. The inclination of the diameter meaſured with the horizon is ſhewn in degrees and minutes by a level and vernier on a graduated circle, at the breech of the teleſcope.

"The method of adjuſting and uſing the catoptric micrometer is too obvious to require any explanation: it is only neceſſary to obſerve, that, beſides the table for reducing the revolutions and parts of the ſcrew to minutes, ſeconds, &c. it may require a table for correcting a very ſmall error which ariſes from the excentric motion of the half-mirrors. By this motion their centres of curvature will (when the angle to be meaſured is large) approach a little towards the large mirror: the equation for this purpoſe in ſmall angles is inſenſible; but when angles to be meaſured exceed ten minutes, it ſhould not be neglected. Or, the angle meaſured may be corrected by diminiſhing it in the proportion the verſed ſine of the angle meaſured, ſuppoſing the excentricity radius, bears to the focal length of the ſmall mirror.

"The teleſcope to which the catoptric micrometer is applied is of the Caſſegrain conſtruction. The great ſpeculum is about 22 inches focus, and bears an aperture of $5\frac{1}{10}$ inches, which is conſiderably larger than thoſe of the ſame focal length are generally made: indeed, the apparent utility of this micrometer makes me wiſh to ſee the reflecting teleſcope meet with further improvements. I believe it would more tend to the advancement of the art of working mirrors, if writers on this ſubject, inſtead of giving us their methods of working imaginary parabolas, would demonſtrate the properties of curves for mirrors, which, placed in a teleſcope, will ſhew images of objects perfectly free from aberration; or, what will yet be more uſeful in practice, of what forms ſpecula might be made, that the aberration cauſed by one mirror may be corrected by that of the other. If mathematicians aſſume *data* which really exiſt, they muſt ſee, that when the two ſpecula of a reflecting teleſcope are parabolas, they cauſe a very conſiderable aberration, which is negative, that is to ſay, the focus of the extreme ray is longer than thoſe of the middle ones. If the large ſpeculum is a parabola, the ſmall one ought to be an ellipſe; but when the ſmall ſpeculum is ſpherical, which is generaly the caſe in practice, if concave, the figure of the large ſpeculum ought to be an hyperbola; if convex, the large ſpeculum ought to be an ellipſe, to free the teleſcope from aberration.

"This will be eaſier underſtood by attending to the poſitions of the firſt and ſecond images; when a curve is of ſuch form that lines drawn from each image, and meeting in any part of the curve, make equal angles with the tangent to the curve at that point, it is evident, that ſuch curve will be free from aberration.

"This is the property of a circle when the radiant and image are in the ſame place; but, when they recede from each other, of an ellipſe, of ſuch form that the radiant and image are in the two *foci*, till, one diſtance becoming infinite the ellipſe changes into a parabola, and to an hyperbola when the focus is negative; that is to ſay, when reflected rays diverge, and the focus is on the oppoſite ſide of the mirror.

"Theſe principles made me prefer Caſſegrain's conſtruction of the reflecting teleſcope to either the Gregorian or Newtonian. In the former, errors cauſed by one ſpeculum are diminiſhed by thoſe in the other.

"From a property of the reflecting teleſcope (which has not been attended to) that the apertures of the two ſpecula are to each other very nearly in the proportion of their focal lengths, it follows, that their aberrations will be to each other in the ſame proportion; and theſe aberrations are in the ſame direction, if the two ſpecula are both concave; or in contrary directions, if one ſpeculum is concave, and the other convex.

"In the Gregorian conſtruction, both ſpecula being concave, the aberration at the ſecond image will be the ſum of the aberrations of the two mirrors; but in the Caſſegrain conſtruction, one mirror being concave, and the other convex, the aberration at the ſecond image will be the difference between their aberrations. By aſſuming ſuch proportions for the *foci* of the ſpecula as are generally uſed in the reflecting teleſcope, which is about as 1 to 4, the aberration in the Caſſegrain conſtruction will be to that in the Gregorian as 3 to 5.

"I have mentioned theſe circumſtances in hopes of recommending the demonſtration of curves ſuited to the purpoſes of optics to the attention of mathematicians, which would be of great uſe to artiſts.

"I ſhall conclude with the deſcription of a new micrometer ſuited to the principle of refraction; being ſenſible that both principles have their peculiar advantages. Though the former part of this paper proves my partiality to the principle of reflection applied to micrometers, yet the favourable opinion I have of the refracting teleſcope made me attentively conſider ſome means of applying a micrometer to it, which might obviate the errors complained of in the former part of this paper.

"The application of any lens or medium between the object-glaſs and its focus muſt inevitably deſtroy the diſtinctneſs of the image; I therefore have employed for the micrometer-glaſs, one of the eye-glaſſes requiſite in the common conſtruction of the teleſcope; but if it ſhould be found neceſſary to apply an additional eye-glaſs for the conveniency of enlarging the ſcale, I am able thereby to correct both the colours and ſpherical aberration of the firſt eye-glaſs.

"This micrometer is applied to the erect eye-tube of a refracting teleſcope, and is placed in the conjugate focus of the firſt eye-glaſs: hence ariſes its great ſuperiority to the object-glaſs micrometer. It has been before obſerved, that if a micrometer is applied at the object-glaſs, the imperfections of its glaſs are magnified by the whole power of the teleſcope; but in this poſition, the image being conſiderably magnified before it comes to the micrometer, any imperfection in its glaſs will be magnified only by the remaining eye-glaſſes,

glasses, which in any telescope seldom exceeds five or six times.

"By this position the size of the micrometer glass will not be the $\frac{1}{100}$ part of the area which would be required if it was placed in the object-glass; and, notwithstanding this great disproportion of size, which is of great moment to the practical optician, the same extent of scale is preserved, and the images are uniformly bright in every part of the field of the telescope.

"Fig. 4. represents the glasses of a refracting telescope; $x y$ the principal pencil of rays from the object-glass O; $t t$ and $u u$, the axis of two oblique pencils; a, the first eye-glass; m, its conjugate focus, or the place of the micrometer; b the second eye-glass; c the third; and d the fourth, or that which is nearest the eye. Let p be the diameter of the object-glass, e the diameter of a pencil at m, and f the diameter of the pencil at the eye; it is evident, that the axis of the pencils from every part of the image will cross each other at the point m; and e, the width of the micrometer-glass, is to p the diameter of the object-glass as $m a$ is to $g o$, which is the proportion of the magnifying power at the point m; and the error caused by an imperfection in the micrometer-glass placed at m will be to the error, had the micrometer been at O, as m is to p.

"Fig. 3. represents the micrometer; A, a convex or concave lens divided into two equal parts by a plane across its centre; one of these semi-lenses is fixed in a frame B, and the other in the frame E; which two frames slide on a plate H, and are pressed against it by thin plates $a a$: the frames B and E are moved in contrary directions by turning the button D; L is a scale of equal parts on the frame B; it is numbered from each end towards the middle with 10, 20, &c. There are two verniers on the frame E, one at M and the other at N, for the conveniency of measuring the diameter of a planet, &c. on both sides the zero. The first division on both these verniers coincides at the same time with the two zeros on the scale L; and, if the frame is moved towards the right, the relative motion of the two frames is shewn on the scale L by the vernier M; but if the frame B be moved towards the left, the relative motion is shewn by the vernier N.

"This micrometer has a motion round the axis of vision, for the conveniency of measuring the diameter of a planet, &c. in any direction, by turning an endless screw F, and the inclination of the diameter measured with the horizon is shewn on the circle g by a vernier on the plate V. The telescope may be adjusted to distinct vision by means of an adjusting screw, which moves the whole eye-tube with the micrometer nearer or farther from the object-glass, as telescopes are generally made; or the same effect may be produced in a better manner, without moving the micrometer, by sliding the part of the eye-tube m on the part n, by help of a screw or pinion. The micrometer is made to take off occasionally from the eye-tube, that the telescope may be used without it."

MICROPUS, BASTARD CUDWEED; a genus of the polygamia segregata order, belonging to the syngenesia class of plants. There are two species, the supinus and erectus; but only the former is ever cultivated in gardens. It is an annual plant growing naturally in Portugal, in places near the sea. The root sends out several trailing stalks, about six or eight inches long, which are garnished with small, oval, silvery leaves, whose bases embrace the stalks. The flowers comes out in clusters from the wings of the stalks, and are very small, and of a white colour. It flowers in June and July; and is frequently preserved in gardens on account of the beauty of its silvery leaves. It is easily propagated by seed sown in autumn, and requires no other culture but to be kept free from weeds.

MICROSCOPE, an optical instrument, consisting of lenses, or mirrors, by means of which small objects appear larger than they do the naked eye. Single microscopes consist of lenses or mirrors; or if more lenses or mirrors be made use of, they only serve to throw light upon the object, and not contribute to enlarge the image of it. Double microscopes are those in which the image of an object is composed by means of more lenses or mirrors than one. For the principles on which the construction of microscopes depend, and the best methods of making them, see (the *Index* subjoined to) OPTICS.

MICROSCOPIC OBJECTS. All things too minute to be viewed distinctly by the naked eye, are proper objects for the microscope. Whatever object offers itself as the subject of our examination, the size, contexture, and nature of it are first to be considered, in order to apply to it such glasses and in such a manner as may shew it best. The first step should always be to view the whole of it together, with such a magnifier as can take it all in at once; and after this the several parts of it may the more fitly be examined, whether remaining on the object or separated from it. The smaller the parts are, the more powerful ought the magnifiers to be which are employed: the transparency or opacity of the object must also be considered, and the glasses employed accordingly suited thereto; for a transparent object will bear a much greater magnifier than one which is opake, since the nearness that a glass must be placed at, unavoidably darkens an object if in its own nature opake, and renders it very difficult to be seen, unless by the help of the apparatus contrived for that purpose, which has a silver speculum. Most objects, however, become transparent by being divided into extremely thin parts.

The nature of the object also, whether it be alive or dead, a solid or a fluid, an animal, a vegetable, or a mineral substance, must likewise be considered, and all the circumstances of it attended to, that we may apply it in the most advantageous manner. If it be a living object, care must be taken not to squeeze or injure it, that we may see it in its natural state and full perfection. If it be a fluid, and that too thick, it must be diluted with water; and if too thin, we should let some of its watery parts evaporate. Some substances are fittest for observation when dry, others when moistened; some when fresh, and others after they have been kept some time.

Light is the next thing to be taken care of, for on this the truth of all our observations depends; and a very little observation will shew how very different objects appear in one degree of it to what they do in another;

other; fo that every new object fhould be viewed in all degrees of light, from the greateft glare of brightnefs to perfect obfcurity; and that in all pofitions to each degree, till we hit upon the certain form and figure of it. In many objects it is very difficult to diftinguifh between a prominency and a depreffion, a black fhadow and a black ftain; and in colour, bebetween a bright reflection and whitenefs. The eye of a fly in one kind of light appears like a lattice drilled full of holes, in the fun-fhine like a folid fubftance covered with golden nails; in one pofition like a furface covered with pyramids, in another with cones, and in others with ftill different fhapes.

The degree of light muft always be fuited to the object. If that be dark, it muft be feen in a full and ftrong light; but if tranfparent, the light fhould be proportionably weak; for which reafon there is a contrivance both in the fingle and double microfcope to cut off abundance of the rays, when fuch tranfparent objects are to be examined by the largeft magnifiers. The light of a candle for many objects, and efpecially for fuch as are very bright and tranfparent, and very minute, is preferable to day-light: for others, a ferene day-light is beft: but fun-fhine is the worft light of all; for it is reflected from objects with fo much glare, and exhibits fuch gaudy colours, that nothing can be determined from it with any certainty. This, however, is not to be extended to the folar or *camera obfcura Microfcope;* for in that nothing but fun-fhine can do, and the brighter that is, the better; but in that way we do not fee the object itfelf on which the fun-fhine is caft, but only the image or fhadow of it exhibited on a fcreen; and therefore no confufion can arife from the glaring reflection of the fun's rays from the object to the eye, which is the cafe in other microfcopes. But then in that folar way we muft reft contented with viewing the true form and fhape of an object, without expecting to find its natural colour; fince no fhadow can poffibly wear the colour of the body it reprefents.

Moft objects require alfo fome management in order to bring them properly before the glaffes. If they are flat and tranfparent, and fuch as will not be injured by preffure, the beft way is to inclofe them in fliders between two Mufcovy talcs or ifinglaffes. This way the feathers of butterflies, the fcales of fifhes, and the farinæ of flowers, may be very conveniently preferved, as alfo the parts of infects, the whole bodies of minute ones, and a great number of other things. Thefe are to be kept in fliders, each containing three, four, or more holes: and thefe muft not be filled promifcuoufly; but all the things preferved in one flider fhould be fuch as require one and the fame magnifying power to view them, that there may not be a neceffity of changing the glaffes for every object; and the fliders fhould be marked with the number of the magnifier it is proper to be viewed with. In placing the objects in the fliders, it is always proper to have a fmall magnifier, of about an inch focus, in your hand, to examine and adjuft them by, before they are fixed down with the rings.

Small living objects, fuch as lice, fleas, bugs, mites, minute fpiders, &c. may be placed between thefe talcs without injuring them, if care be taken to lay on the brafs rings without preffing them down, and they will remain alive many weeks in this manner; but if they are too large to be treated thus, they fhould be either preferved between two concave glaffes, or elfe viewed immediately, by holding them in the pliers, or fticking them on the point at the other end of that inftrument.

If fluids come under examination, to difcover the animalcules in them, a fmall drop is to be taken with a hair-pencil, or on the nib of a clean pen, and placed on a plate of glafs; and if they are too numerous to be thus feen diftinctly, fome water, warmed by holding it in the mouth, muft be added to the drop, and they will then feparate and be feen diftinctly. This is particularly neceffary in viewing the animalcules in the *femen mafculinum* of all creatures; which, though extremely minute, are always fo numerous, that without this caution their true form can feldom be feen. But if we are to fee the falts in a fluid, the contrary method muft be obferved, and the plate of glafs muft be held gently over the fire, till part of the liquor is evaporated.

The diffection of minute animals, as lice, fleas, &c. requires patience and care: but it may be done very accurately by means of a needle and a fine lancet, placing the creature in a drop of water; for then the parts will readily unfold themfelves, and the ftomach, guts, &c. be very diftinctly feen.

Thefe feem the beft ways of preferving tranfparent objects; but the opake ones, fuch as feeds, woods, &c. require a very different treatment, and are beft preferved and viewed in the following manner.

Cut cards into fmall flips about half an inch long and a tenth of an inch broad; wet thefe half-way of their length in gum-water, and with that faften on feveral parcels of the object; and as the fpots of cards are of different colours, fuch fhould be chofen for every object as are the moft different from its own colours. Thefe are very convenient for viewing by the microfcope made for opake objects with the filvered fpeculum; but they are proper for any microfcope that can view opake bodies.

A fmall box fhould be contrived for thefe flips, with little fhallow holes for the reception of each: and this is conveniently done, by cutting pieces of pafte-board, fuch as the covers of books are made of, to the fize of the box, fo that they will juft go into it; and then cutting holes through them with a fmall chiffel, of the fhape of the flips of card: thefe pafte-boards having then a paper pafted over their bottom, are cells very proper for the reception of thefe flips, which may be taken out by means of a pair of plyers, and will be always ready for ufe.

Great caution is to be ufed in forming a judgment on what is feen by the microfcope, if the objects are extended, or contracted, by force or drinefs. Nothing can be determined about them, without making the proper allowances; and different lights and pofitions will often fhew the fame object as very different from itfelf. There is no advantage in any greater magnifier than fuch as is capable of fhewing the object in view diftinctly; and the lefs the glafs magnifies, the more pleafantly the object is always feen.

The colours of objects are very little to be depended on, as feen by the microfcope; for their feveral component particles being by this means removed to great diftances from one another, may give reflections very

very different from what they would, if seen by the naked eye.

The motions of living creatures also, or of the fluids contained in their bodies, are by no means to be hastily judged of, from what we see by the microscope, without due consideration; for as the moving body, and the space wherein it moves, are magnified, the motion must be so too; and therefore that rapidity with which the blood seems to pass through the vessels of small animals must be judged of accordingly: suppose, for instance, that a horse and a mouse move their limbs exactly at the same time, if the horse runs a mile while the mouse runs 50 yards; though the number of steps are the same in both, the motion of the horse must notwithstanding be allowed the swiftest; and the motion of a mite, as viewed by the naked eye, or through the microscope, is perhaps not less different.

MIDAS, in fabulous history, a famous king of Phrygia, who having received Bacchus with great magnificence, that god, out of gratitude, offered to grant him whatever he should ask. Midas desired that every thing he touched should be changed into gold. Bacchus consented; and Midas, with extreme pleasure, every where found the effects of his touch. But he had soon reason to repent of his folly: for wanting to eat and drink, the aliments no sooner entered his mouth, than they were changed into gold; which obliged him to have recourse to Bacchus again, to beseech him to restore him to his former state; on which the god ordered him to bathe in the river Pactolus, which from thence forward had golden sands. Some time after, being chosen judge between Pan and Apollo, he gave another instance of his folly and bad taste, in preferring Pan's music to Apollo's; on which the latter being enraged, gave him a pair of asses ears. See the article Apollo.

Midas, *Ear-shell*, the smooth ovato-oblong buccinum, with an oblong and very narrow mouth. It consists of six volutions, but the lower one alone makes up almost the whole shell.

MID-heaven, the point of the ecliptic that culminates, or in which it cuts the meridian.

MIDDLEBURG, one of the friendly islands in the south-sea. This island was first discovered by Tasman, a Dutch navigator, in January 1742-3; and is called by the natives *Ea-Oo-whe*: it is about sixteen miles from north to south, and in the widest part about eight miles from east to west. The skirts are chiefly laid out in plantations, the south-west and north-west sides especially. The interior parts are but little cultivated, though very capable of it: but this neglect adds greatly to the beauty of the island; for here are agreeably dispersed groves of cocoa-nuts and other trees, lawns covered with thick grass, here and there plantations and paths leading to every part of the island, in such beautiful disorder, as greatly to enliven the prospect. The hills are low; the air is delightful; but unfortunately water is denied to this charming spot. Yams, with other roots, bananas, and bread-fruit, are the principal articles of food; but the latter appeared to be scarce. Here is the pepper-tree, or *ava-ava*, with which they make an intoxicating liquor, in the same disgusting manner as is practised in the Society Islands. Here are several odoriferous trees and shrubs, particularly a species of the lemon tribe; and the botanical gentlemen met with various new species of plants. Here also are a few hogs and fowls.

There are no towns or villages; most of the houses are built in plantations, which are laid out in different parts, with no other order than what convenience requires. They are neatly constructed, but are less roomy and convenient than those in the Society Isles. The floors are a little raised, and covered with thick strong mats. The same sort of matting serves to inclose them on the windward side, the others being open. They have little areas before most of them, which are planted round with trees or ornamental shrubs, whose fragrance perfumes the air. Their household furniture consists of a few wooden platters, cocoa-nut shells, and pillows made of wood, and shaped like four-footed stools or forms: their common clothing, with the addition of a mat, serves them for bedding.

The natives are of a clear mahogany or chesnut brown, with black hair, in short frizzled curls, which seems to be burnt at the tips; their beards are cut or shaven. The general stature of the men is equal to our middle size, from five feet three to five ten inches; the proportions of the body are very fine, and the *contours* of the limbs extremely elegant, though something more muscular than at O-Taheitee, which may be owing to a greater and more constant exertion of strength in their agriculture and domestic œconomy. Their features are extremely mild and pleasing; and differ from the O-Taheitian faces in being more oblong than round, the nose sharper, and the lips rather thinner. The women are, in general, a few inches shorter than the men, but not so small as the lower class of women at the Society Islands. The practice of puncturing the skin, and blacking it, which is called *tattowing*, is in full force among the men here, for their belly and loins are very strongly marked in configurations more compounded than those at O-Taheitee. The tenderest parts of the body were not free from these punctures; the application of which, besides being very painful, must be extremely dangerous on glandulous extremities.

The men in general go almost naked, having only a small piece of cloth round the loins, but some wrap it in great abundance round them from their waist: this cloth is manufactured much like that at O-Taheitee, but overspread with a strong glue, which makes it stiff, and fit to resist the wet. The women are likewise covered from the waist downwards: they often have loose necklaces, consisting of several strings of small shells, seeds, teeth of fishes; and in the middle of all, the round *operculum*, or cover of a shell as large as a crown-piece. The men frequently wear a string round their necks, from which a mother-of-pearl shell hangs down on the breast; both the ears of the women were perforated with two holes, and a cylinder cut out of tortoise-shell or bone was struck through both the holes. The most remarkable circumstance observed of this people was, that most of them wanted the little finger on one, and sometimes on both hands: the difference of sex or age did not exempt them from this amputation; for even among the few children that were seen running about naked, the greater part had already suffered such loss. This circumstance was observed by Tasman. Another singularity which was observed to be very general among these

Middleburg these people was, a round ſpot on each cheek-bone, which appeared to have been burnt or bliſtered. On ſome it ſeemed to have been recently made, on others it was covered with ſcurf, and many had only a ſlight mark of its former exiſtence: how, or for what purpoſe it was made, could not be learnt. The women here, in general, were reſerved; and turned, with diſguſt, from the immodeſt behaviour of ungovernable ſeamen: there were not, however, wanting ſome who appeared to be of eaſy virtue, and invited their lovers with laſcivious geſtures. The language ſpoken here is ſoft, and not unpleaſing; and whatever they ſaid was ſpoken in a kind of ſinging tone. O-Mai and Mahine, who were both paſſengers on board the ſhip, at firſt declared that the language was totally new, and unintelligible to them; however, the affinity of ſeveral words being pointed out, they ſoon caught the particular modification of this dialect, and converſed much better with the natives than any on board the ſhips could have done, after a long intercourſe. They have the neateſt ornaments imaginable, conſiſting of a number of little flat ſticks, about five inches long, of a yellow wood like box, firmly and elegantly connected together at the bottom by a tiſſue of the fibres of cocoa-nut, ſome of which were of their natural colour, and others dyed black; the ſame fibres were likewiſe uſed in the making of baſkets, the taſte of which was highly elegant, and varied into different forms and patterns. Their clubs are of a great variety of ſhapes, and many of them ſo ponderous as ſcarce to be managed with one hand. The moſt common form was quadrangular, ſo as to make a rhomboid at the broad end, and gradually tapering into a round handle at the other. Far the greater part were curved all over in many chequered patterns, which ſeemed to have required a long ſpace of time, and incredible patience, to work up; as a ſharp ſtone, or a piece of coral, are the only tools made uſe of: the whole ſurface of the plain clubs was as highly poliſhed as if an European workman had made them with the beſt inſtruments. Beſides clubs, they have ſpears of the ſame wood, which were ſometimes plain ſharp-pointed ſticks, and ſometimes barbed with a ſting-ray's tail. They have likewiſe bows and arrows of a peculiar conſtruction: the bow, which is ſix feet long, is about the thickneſs of a little finger, and when ſlack forms a ſlight curve; its convex part is channelled with a ſingle deep groove, in which the bow-ſtring is lodged. The arrow is made of reed, near ſix feet long, and pointed with hard wood: when the bow is to be bent, inſtead of drawing it ſo as to increaſe the natural curvature, they draw it the contrary way, make it perfectly ſtraight, and then form the curve on the other ſide. Moſt of their canoes have outriggers, made of poles, and their workmanſhip is very admirable: two of theſe canoes are joined together with a ſurpriſing exactneſs, and the whole ſurface receives a very curious poliſh. Their paddles have ſhort broad blades, ſomething like thoſe at O-Taheitee, but more neatly wrought, and of better wood.

They keep their dead above ground, after the manner of the Society Iſlands; as a corpſe was ſeen depoſited on a low hut.

Here were ſeen ſeveral men and women afflicted with leprous diſeaſes, in ſome of whom the diſorder had riſen to a high degree of virulence; one man in particular had his back and ſhoulders covered with a large cancerous ulcer, which was perfectly livid within, and of a bright yellow all round the edges. A woman was likewiſe unfortunate enough to have her face deſtroyed by it in the moſt ſhocking manner; there was only a hole left in the place of her noſe; her cheek was ſwelled up, and continually oozing out a purulent matter; and her eyes ſeemed ready to fall out of her head, being bloody and ſore: though theſe were ſome of the moſt miſerable objects that could poſſibly be ſeen, yet they ſeemed to be quite unconcerned about their misfortunes, and traded as briſkly as any of the reſt.

Middleſex, MIDDLESEX, a county of England in which ſtands the city of London. This county, which derives its name from its ſituation amidſt the three kingdoms of the Eaſt, Weſt, and South Saxons, is bounded on the weſt by Buckinghamſhire, from which it is ſeparated by the little river Coln and the ſhireditch; on the north by Hertfordſhire; on the eaſt by the river Lea, which parts it from Eſſex; and on the ſouth by the Thames, which divides it from Surry. It is but of ſmall extent, in length not exceeding 21 miles, in breadth 15, and in circumference eighty; but, by reaſon of the cities of London and Weſtminſter, and the numerous large villages in their nighbourhood, it is by far the moſt populous and wealthy in England. The whole of it lies in the dioceſe of London; and is divided into ſix hundreds, two liberties, and ſeventy-three pariſhes, which, beſides London and Weſtminſter, contains five market-towns. There are ſeveral royal parks in it, and a great many chapels of eaſe. The ſheriffs are not appointed by the king, but choſen by the liverymen of London.

As the ſoil is gravelly, and exceedingly well cultivated, in conſequence of the great number of inhabitants, the air is very pure and wholeſome. The great quantities of rich manure produced by ſuch multitudes of people and cattle has ſo improved and enriched the lands, that they are extremely fruitful in vegetables of all kinds. In the neighbourhood of London there is little or no corn, the land being employed either for feeding cows, raiſing hay, or as garden grounds.

Middleton. MIDDLETON (Dr Conyers), a very celebrated Engliſh divine, the ſon of a clergyman in Yorkſhire, was born at Richmond in 1683. He diſtinguiſhed himſelf, while fellow of Trinity-college Cambridge, by his controverſy with Dr Bentley his maſter, relating to ſome mercenary conduct of the latter in that ſtation. He afterwards had a controverſy with the whole body of phyſicians, on the dignity of the medical profeſſion; concerning which he publiſhed, *De medicorum apud veteres Romanos degentium conditione diſſertatio; qua, contra viros celeberrimos Jacobum Sponium et Richardum Meadium, ſervilem atque ignobilem eam fuiſſe, oſtenditur:* and in the courſe of this diſpute much reſentment and many pamphlets appeared. Hitherto he had ſtood well with his clerical brethren; but he drew the reſentment of the church on him in 1729, by writing "A letter from Rome, ſhewing an exact conformity between popery and paganiſm," &c.; as this letter, though politely written, yet attacked popiſh miracles with a gaiety that appeared dangerous to the cauſe of miracles in general. Nor

were his Objections to Dr Waterland's manner of vindicating Scripture againſt Tindal's "Chriſtianity as old as the Creation," looked on in a more favourable point of view. In 1741, came out his great work, "The hiſtory of the life of M. Tullius Cicero," 2 vols 4to; which is indeed a fine performance, and will probably be read as long as taſte and polite literature ſubſiſt among us: the author has nevertheleſs fallen into the common error of biographers, who often give panegyrics inſtead of hiſtory. In 1748, he publiſhed, "A free inquiry into the miraculous powers which are ſuppoſed to have ſubſiſted in the Chriſtian church from the earlieſt ages, through ſeveral ſucceſſive centuries." He was now attacked from all quarters; but before he took any notice of his antagoniſts, he ſupplied them with another ſubject in "An examination of the lord biſhop of London's diſcourſes concerning the uſe and extent of prophecy," &c. Thus Dr Middleton continued to diſplay talents and learning, which were highly eſteemed by men of a free turn of mind, but by no means in a method calculated to invite promotion in the clerical line. He was, in 1723, choſen principal librarian of the public library at Cambridge; and if he roſe not to dignities in the church, he was in eaſy circumſtances, which permitted him to aſſert a dignity of mind often forgot in the career of preferment. He died in 1750, at Hilderſham in Cambridgeſhire, an eſtate of his own purchaſing; and in 1752, all his works, except the life of Cicero, were collected in 4 vols, 4to.

MIDIAN, or *Madian*, (anc. geog.) a town on the ſouth ſide of Arabia Petræa; ſo called from one of the ſons of Abraham by Keturah. Another Midian, near the Arnon and Æoplis, in ruins in Jerome's time; with the daughters of theſe Midianites the Iſraelites committed fornication, and were guilty of idolatry. A branch of the Midianites dwelt on the Arabian gulph, and were called *Kenites;* ſome of whom turned proſelytes, and dwelt with the Iſraelites in the land of Canaan.

MID-LOTHIAN. See Lothian.

MIDSHIP-frame, a name given to that timber, or combination of pieces formed into one timber, which determines the extreme breadth of the ſhip, as well as the figure and dimenſion of all the inferior timbers.

In the article Ship-*Building*, the reader will find a full explanation of what is meant by a frame of timbers. He will alſo perceive the outlines of all the principal frames, with their gradual dimenſions, from the midſhip-frame delineated in the plane of projection annexed to that article. As the parts of which the ſeveral frames are compoſed have the ſame relation to each other throughout the veſſel; and as all the correſponding pieces, without and within thoſe frames, are alſo nearly alike, and fixed in the ſame manner; it will be here ſufficient for our purpoſe to repreſent the principal, or midſhip-frame, together with its correſponding parts, which are as follow:

Plate CLXXV. fig. 8. A, the keel, with *a* the falſe keel beneath it.

B, the chocks fixed upon the kelſon, to retain the oppoſite pieces of the *riders* firmly together.

C, one of the beams of the orlop.

D, one of the lower-deck beams; with *d* the beams of the upper deck.

E, the hanging-knees, by which the beams are attached to the timbers.

F, the ſtandards, which are fixed above the decks to which they belong.

G, the clamps, which ſuſtain the extremities of the beams.

H, the gun-ports of the lower-deck; with *h* the ports of the upper-deck.

I, K, L, different pieces of *thick-ſtuff*, placed oppoſite to the ſeveral ſcarfs, or joinings, in the frame of timbers.

M, the planks of the deck.

N, the water-ways.

O, the planks of the ceiling, between the ſeveral ranges of thick-ſtuff.

P, the ſpirketing.

Q, the main-wale, to fortify the ſhip's ſide oppoſite to the lower deck.

R, the channel-wale, oppoſite to the upper-deck.

S, the waiſt-rail.

T, the ſtring, with the moulding under the gunwale.

U, the floor-timbers, which are laid acroſs the keel, and bolted to it.

V, the ſeveral futtocks; and W the top-timbers, which are all united into one frame.

X, the kelſon.

MIDSHIPMAN, a ſort of naval cadet, appointed by the captain of a ſhip of war, to ſecond the orders of the ſuperior officers, and aſſiſt in the neceſſary buſineſs of the veſſel, either aboard or aſhore.

The number of midſhipmen, like that of ſeveral other officers, is always in proportion to the ſize of the ſhip to which they belong. Thus a firſt-rate man of war has 24, and the inferior rates a ſuitable number in proportion. No perſon can be appointed lieutenant without having previouſly ſerved two years in the royal navy in this capacity, or in that of *mate*, beſides having been at leaſt four years in actual ſervice at ſea, either in merchant-ſhips, or in the royal navy.

Midſhipman is accordingly the ſtation in which a young volunteer is trained in the ſeveral exerciſes neceſſary to attain a ſufficient knowledge of the machinery, movements, and military operations of a ſhip, to qualify him for a ſea-officer.

On his firſt entrance in a ſhip of war, every midſhipman has ſeveral diſadvantageous circumſtances to encounter. Theſe are partly occaſioned by the nature of the ſea-ſervice; and partly by the miſtaken prejudices of people in general reſpecting naval diſcipline, and the genius of ſailors and their officers. No character, in their opinion, is more excellent than that of the common ſailor, whom they generally ſuppoſe to be treated with great ſeverity by his officers, drawing a compariſon between them not very advantageous to the latter. The midſhipman uſually comes aboard tinctured with theſe prejudices, eſpecially if his education has been amongſt the higher rank of people; and if the officers happen to anſwer his opinion, he conceives an early diſguſt to the ſervice, from a very partial and incompetent view of its operations. Blinded by theſe prepoſſeſſions, he is thrown off his guard, and very ſoon ſurpriſed to find, amongſt thoſe honeſt ſailors,

Midshipman. sailors, a crew of abandoned miscreants, ripe for any mischief or villainy. Perhaps, after a little observation, many of them will appear to him equally destitute of gratitude, shame, or justice, and only deterred from the commission of any crimes by the terror of severe punishment. He will discover, that the pernicious example of a few of the vilest in a ship of war are too often apt to poison the principles of the greatest number, especially if the reins of discipline are too much relaxed, so as to foster that idleness and dissipation, which engender sloth, diseases, and an utter profligacy of manners. If the midshipman, on many occasions, is obliged to mix with these, particularly in the exercises of extending or reducing the sails in the tops, he ought resolutely to guard against this contagion, with which the morals of his inferiors may be infected. He should, however, avail himself of their knowledge, and acquire their expertness in managing and fixing the sails and rigging, and never suffer himself to be excelled by an inferior. He will probably find a virtue in almost every private sailor, which is entirely unknown to many of his officers: that virtue is emulation, which is not indeed mentioned amongst their qualities by the gentlemen of *terra firma*, by whom their characters are often copiously described with very little judgment. There is hardly a common tar who is not envious of superior skill in his fellows, and jealous on all occasions to be outdone in what he considers as a branch of his duty: Nor is he more afraid of the dreadful consequences of whistling in a storm, than of being stigmatized with the opprobrious epithet of *lubber*. Fortified against this scandal, by a thorough knowledge of his business, the sailor will sometimes sneer in private at the execution of orders which to him appear aukward, improper, or unlike a seaman. Nay, he will perhaps be malicious enough to suppress his own judgment, and, by a punctual obedience to command, execute whatever is to be performed in a manner which he knows to be improper, in order to expose the person commanding to disgrace and ridicule. Little skilled in the method of the schools, he considers the officer who cons his lesson by rote as very ill qualified for his station, because particular situations might render it necessary for the said officer to assist at putting his own orders in practice. An ignorance in this practical knowledge will therefore necessarily be thought an unpardonable deficiency by those who are to follow his directions. Hence the midshipman who associates with these sailors in the tops, till he has acquired a competent skill in the service of extending or reducing the sails, &c. will be often entertained with a number of scurrilous jests, at the expence of his superiors. Hence also he will learn, that a timely application to those exercises can only prevent him from appearing in the same despicable point of view, which must certainly be a cruel mortification to a man of the smallest sensibility.

If the midshipman is not employed in these services, which are undoubtedly necessary to give him a clearer idea of the different parts of his occupation, a variety of other objects present themselves to his attention. Without presuming to dictate the studies which are most essential to his improvement, we could wish to recommend such as are most suitable to the bent of his inclination. Astronomy, geometry, and mechanics, which are in the first rank of science, are the materials which form the skilful pilot, and the superior mariner. The theory of navigation is entirely derived from the two former, and all the machinery and movements of a ship are founded upon the latter. The action of the wind upon the sails, and the resistance of the water at the stem, naturally dictate an inquiry into the property of solids and flusds: and the state of the ship, floating on the water, seems to direct his application to the study of hydrostatics and the effects of gravity. A proficiency in these branches of science will equally enlarge his views, with regard to the operations of naval war, as directed by the efforts of powder and the knowledge of projectiles. The most effectual method to excite his application to those studies is, perhaps, by looking round the navy, to observe the characters of individuals. By this inquiry he will probably discover, that the officer, who is eminently skilled in the sciences, will command universal respect and approbation; and that whoever is satisfied with the despicable ambition of shining the hero of an assembly, will be the object of universal contempt. The attention of the former will be engaged in those studies which are highly useful to himself in particular, and to the service in general. The employment of the latter is to acquire those superficial accomplishments that unbend the mind from every useful science, emasculate the judgment, and render the hero infinitely more dextrous at falling into his station in the dance than in the line of battle.

Unless the midshipman has an unconquerable aversion to the acquisition of those qualifications, which are so essential to his improvement, he will very rarely want opportunities of making a progress therein. Every step he advances in those meritorious employments will facilitate his accession to the next in order. If the dunces, who are his officers or mess-mates, are rattling the dice, roaring bad verses, hissing on the flute, or scraping discord from the fiddle, his attention to more noble studies will sweeten the hours of relaxation. He should recollect that no example from fools ought to influence his conduct, or seduce him from that laudable ambition which his honour and advantage are equally concerned to pursue.

MIDWIFERY,

THE art of assisting women in the birth of children. It is supposed to comprehend also the management of women both before and after delivery, as well as the treatment of the child in its most early state.

History. The art of midwifery is certainly almost coeval with mankind. The first midwife of whom mention is made under that name, assisted at the second labour of Rachel, the wife of Jacob. Another midwife is spoken of in Genesis, at the lying-in of Thamar, who was deli-

delivered of twins. But the most honourable mention of midwives is that in Exodus, when Pharaoh king of Egypt, who had a mind to destroy the Hebrews, commanded two midwives to kill all the male children of the Hebrew women; which command they disobeyed, and thereby obtained a recompence from God.

From all the passages in Scripture where midwives are mentioned, it is plain, that women were the only practitioners of this art among the Hebrews. Among the Greeks also women assisted at labours. Phanarete the mother of Socrates was a midwife. Plato speaks at large of midwives, explains their functions, regulates their duty, and remarks that they had at Athens the right of proposing or making marriages. Hippocrates makes mention of midwives, as well as Aristotle, Galen, and Aëtius. This last even frequently quotes a woman called *Aspasia*, who was probably a midwife. They were called among the Greeks Μαιαι, or Ιατρομαιαι; that is to say, *mamma*, or *grand-mamma*.

We are still better acquainted with the customs of the Romans, and know that they employed women only. This may be deduced from the comedies of Plautus and Terence alone. We there see that they are women only who are called to assist persons in labour. Besides, Pliny, in his Natural History, frequently speaks of midwives and their duties; and names two, *Sotira* and *Salpe*, who had apparently the greatest reputation. Women were also employed after the fall of the empire; and it is certain, that, till lately, all civilized nations have employed women only as midwives. This appears even from their names in many different languages, which are all feminine. There were, however, especially in great cities, surgeons who applied themselves to the art of midwifery, and made it their peculiar study. They were sent for in difficult cases, where the midwives found their incapacity; and then the surgeon endeavoured to deliver the woman by having recourse to instruments useful in those cases, as by crotchets, crows-bills, &c.; but as these cases happened but seldom, women remained in possession of this business. It is certain, according to Astruc, that Maria Theresia wife of Lewis XIV. employed women only in her labours; and the example of the queen determined the conduct of the princesses and court-ladies, and likewise of the other ladies of the city. The same author tells us, that he has been assured, that the epoch of the employment of men-midwives goes no farther back than the first lying-in of Madam de la Valiere in 1663. As she desired it might be kept a profound secret, she sent for Julian Clement a surgeon of reputation. He was conducted with the greatest secrecy into an house where the lady was, with her face covered with a hood; and where it is said the king was concealed in the curtains of the bed. The same surgeon was employed in the subsequent labours of the same lady; and as he was very successful with her, men-midwives afterwards came into repute, and the princesses made use of surgeons on similar occasions; and as soon as this became fashionable, the name of *acoucheur* was invented to signify this class of surgeons. Foreign countries soon adopted the custom, and likewise the name of *acoucheurs*, though they had no such term in their own language; but in Britain they have more generally been called *men-midwives*.

In opposition to this account, which is taken from Astruc, that author tells us, that he is aware of an objection from Hyginus, who asserts, that the ancients had no midwives; which made the women, through modesty, rather choose to run the risk of death than to make use of men on this occasion. For the Athenians, he adds, had forbid women and slaves to study physic, that is to say, the art of midwifery. A young woman, named *Agnodice*, desirous of learning this art, cut off her hair, dressed herself in the habit of a man, and became a scholar to one Hierophilus. She afterwards followed this business. The women at first refused assistance from her, thinking she was a man; but accepted thereof when she had convinced them that she was a woman.

To this account our author replies, that the authority of Hyginus is by no means to be depended upon. His book is full of solecisms and barbarisms; and therefore cannot be attributed to any writer who lived before the fall of the empire; but must have been the work of an author who lived when the Latin tongue was corrupted; that is, about the seventh or eighth century. The contradictions met with in this book also give room to suspect that it is not the work of one hand, but of several. The authority of such a work, therefore, is by no means sufficient to destroy the testimonies of those writers who affirm, that among the Greeks the care of lying-in women was committed entirely to others of their own sex.

The art of midwifery seems not to have been so soon improved as that of physic. Hippocrates, though an excellent physician, seems to have been a very bad midwife. He was acquainted with no other kind of natural labour than that in which the head presents; and condemns footling labour as fatal both to mother and child: he would have the children in such cases turned, so that the head may present: but, says he, if the arm, or leg, or both, of a living child present, they must, as soon as discovered, be returned into the womb, and the child brought into the passage with its head downwards. For this purpose he advises to roll the woman on the bed to shake her, and make her jump: he proposes the same expedients to procure the child's delivery; and if they do not succeed, he advises to extract it with crotchets, and, whatever happens, to dismember it.

From the time of Hippocrates to that of Celsus, who lived in the reign of the emperor Tiberius, we have no accounts of any improvements in midwifery; but this author gives two very useful directions. 1. In dilating the womb: "We must (says he) introduce the fore-finger, well moistened with hog's lard, into the mouth of the womb, when it begins to open, and in like manner afterwards a second, and so on until all the fingers are introduced, which are then to be used by separating them, as a kind of dilater, to distend the orifice, and facilitate the introduction of the hand which is to act in the womb. 2. Children may be delivered by the feet easily and safely, without crotchets, by taking hold of their legs. For this purpose we must take care to turn children, which are otherwise placed in the womb, with their head or feet downwards."

wards." It is true, Celfus fpeaks of a dead child only; but it was eafy to conclude from thence, that the fame practice might be ufed with fuccefs to deliver a living child. Neverthelefs, this was not done; and, notwithftanding the authority of Celfus, the former prejudice continued for a long time. Tho' Pliny, who lived under the emperors Vefpafian and Titus, was not a phyfician himfelf, yet by condemning footling labour he attefts the opinion of the phyficians of his time. He afferts, as a known fact, that footling labour was a preternatural kind of labour: he adds, that children which came into the world in this manner were called *Agrippa*, that is to fay, born with a great deal of difficulty.

But however common this opinion was, it was never univerfally received; and feveral phyficians of character rofe up, who, without fuffering themfelves to be dazzled with the common prejudice, or feduced by the authority of Hippocrates or Galen, recommended and approved of footling delivery. The queftion then was a long time undecided; and even in 1657, Riverius, a phyfician of reputation, condemned footling labour. Mauriceau alfo remarks, in the firft edition of his book, on the diforders of pregnant women, printed in 1664, that many authors were ftill of opinion, that when the child prefented with its feet, it fhould be turned to make it come with its head foremoft; but after having obferved that it is difficult, if not impoffible, to execute this, he concludes, "it is much better to extract the child by its feet when they prefent, than to run the hazard of doing worfe by turning it." All practitioners, however, are now of the fame opinion; and the knowledge of midwifery has been fo much increafed within this century, that it feems to have nearly attained its ultimate perfection, and its operations reduced almoft to a geometrical certainty: And this, fays Aftruc, is not furprifing; for, after all, the art of midwifery is reduced to the following mechanical problem, "An extenfible cavity of a certain capacity being given, to pafs a flexible body of a given length and thicknefs through an opening dilatable to a certain degree." This might be refolved geometrically, if the different degrees of elafticity of the womb, and ftrength and weaknefs of the child, the greater or leffer difpofition of the blood to inflammation, and the greater or leffer degree of irritability of the nerves, did not occafion that uncertainty which phyfical facts conftantly produce in all phyfico-mathematical queftions.

Chap. I. *Of Pregnancy.*

At the time of conception, and for fome time after, the parts which form the fmall fœtus are fo blended together, that one cannot be diftinguifhed from another. The whole mafs is then called an *ovum*. This ovum confifts of four membranes; the placenta, or after-birth; the funis umbilicalis or navel-ftring, leading to the child; and the furrounding watery fluid in which it floats. Before the child acquires a diftinct and regular form, it is called *embryo*, and afterwards retains the name of *fœtus* till its birth. For the increafe and nutrition of the fœtus, fee the article Generation.

During the progrefs of impregnation the uterus fuffers confiderable changes; but, though it enlarges as the ovum increafes, yet, in regard to its contents, it is never full; for, in early geftation, thefe are confined to the fundus only: and though the capacity of the uterus increafes, yet it is not mechanically ftretched, for the thicknefs of its fides do not diminifh; there is a proportional increafe of the quantity of fluids, and therefore pretty much the fame thicknefs remains as before impregnation.

The gravid uterus is of different fizes in different women; and muft vary according to the bulk of the fœtus and involucra. The fituation will alfo vary according to the increafe of its contents and the pofition of the body. For the firft two or three months, the cavity of the fundus is triangular as before impregnation; but as the uterus ftretches, it gradually acquires a more rounded form. In general, the uterus never rifes directly upwards, but inclines a little obliquely, moft commonly to the right fide; its pofition is never, however, fo oblique, as to prove the fole caufe either of preventing or retarding delivery: its increafe of bulk does not feem to arife merely from diftention, but to depend on the fame caufe as the extenfion of the fkin in a growing child. This is proved from fome late inftances of extra-uterine fœtufes, where the uterus, though there were no contents, was nearly of the fame fize, from the additional quantity of nourifhment tranfmitted, as if the ovum had been contained within its cavity.

The internal furface, which is generally pretty fmooth, except where the placenta adheres, is lined with a tender efflorefcence of the uterus, which, after delivery, appears as if torn, and is thrown off with the cleanfings. This is the *membrana decidua* of Dr Hunter.

Though the uterus, from the moment of conception, is gradually diftended, by which confiderable changes are occafioned, it is very difficult to judge of pregnancy from appearances in the early months. For the firft three months the os tincæ feels fmooth and even, and its orifice as fmall as in the virgin ftate. When any difference can be perceived, about the fourth or fifth month from the defcent of the fundus through the pelvis, the tubercle or projecting part of the os tincæ will feem larger, longer, and more expanded; but, after this period, it fhortens, particularly at its fore-parts and fides, and its orifice or labia begin to feparate, fo as to have its conical appearance deftroyed. The cervix, which in the early months is nearly fhut, now begins to ftretch and to be diftended to the os tincæ; but during the whole term of utero-geftation, the mouth of the uterus is ftrongly cemented with a ropy mucus, which lines it and the cervix, and begins to be difcharged on the approach of labour. In the laft week, when the cervix uteri is completely diftended, the uterine orifice begins to form an elliptical tube, inftead of a fiffure, or to affume the appearance of a ring on a large globe; and often at this time, efpecially in pendulous bellies, difappears entirely, fo as to be out of the reach of the finger in touching. Hence the os uteri is not in the direction of the axis of the womb, as has generally been fuppofed.

About the fourth, or between the fourth and fifth month, the fundus uteri begins to rife above the pubes or brim of the pelvis, and its cervix to be diftended nearly

Spurious gravidity.

nearly one third. In the fifth month the belly swells, like a ball, with the skin tense, the fundus about half way between the pubes and navel, and the neck one half distended. After the sixth month the greatest part of the cervix uteri dilates, so as to make almost one cavity with the fundus. In the seventh month the fundus advances as far as the umbilicus. In the eighth it reaches mid-way between the navel and scrobiculus cordis; and in the ninth to the scrobiculus itself, the neck then being entirely distended, which, with the os tincæ, become the weakest parts of the uterus. Thus at full time the uterus occupies all the umbilical and hypogastric regions; its shape is almost pyriform, that is, more rounded above than below, and having a stricture on that part which is surrounded by the brim of the pelvis.

The appendages of the uterus suffer very little change during pregnancy, except the ligamenta lata, which diminish in breadth as the uterus enlarges, and at full time are almost entirely obliterated.

The most remarkable change happens in the ovarium. A cicatrice of a roundish figure and yellowish colour appears in this body, called by anatomists the *corpus luteum*. It is always to be found in one of the ovaria, and in cases of twins a corpus luteum often appears in both ovaria. It was formerly considered as the calyx ovi; but modern physiologists think it a gland, from whence the seminal fluid is ejected. In early gestation it is most conspicuous, when a cavity is observable, which afterwards collapses; no vessels appear at the centre of this cavity which has the appearance of cicatrix, but all around that centre the substance is vascular.

During the progress of distention, the substance of the uterus becomes much looser, of a softer texture, and more vascular than before conception; its veins particularly, in their diameters, being enlarged in such a manner as to get the name of *sinuses;* they observe a more direct course than the arteries, which run in a serpentine manner, anastomosing with one another and through its whole substance, especially where the placenta adheres, where this vascular appearance is most conspicuous.

The arteries pass from the uterus through the decidua, and open into the substance of the placenta in a slanting direction. The veins also open into the placenta, and by injecting these veins from the uterus with wax, the whole spungy or cellular part of the placenta will be filled.

The muscular structure of the gravid uterus is extremely difficult to be shewn: in the wombs of women who die in labour, or soon after delivery, fibres running in various directions are observable more or less circular, that seem to arise from three distinct origins; viz. from the place where the placenta adheres, and from the aperture or orifice of each of the tubes; but it is almost impossible to demonstrate regular plans of fibres, continued any length without interruption.

Chap. II. *Spurious Gravidity.*

The various diseases incident to the uterine system, and other morbid affections of the abdominal viscera, will frequently excite the symptoms and assume the appearance of utero-gestation. Complaints arising from a simple obstruction, are sometimes mistaken for those of breeding; when a tumour about the region of the uterus is also formed, and gradually becomes more and more bulky, the symptoms it occasions are so strongly marked, and the resemblance to pregnancy so very striking, that the ignorant patient is often deceived, and even the experienced physician imposed on.

Scirrhous, polypous, or sarcomatous tumours in or about the uterus or pelvis; dropsy or ventosity of the uterus or tubes; steatoma or dropsy of the ovaria, and ventral conception, are the common causes of such fallacious appearances. In many of these cases the menses disappear; nausea, retchings, and other symptoms of breeding, ensue; flatus in the bowels will be mistaken for the motion of the child; and in the advanced stages of the disease, from the pressure of the swelling on the adjacent parts. Tumefaction and hardness of the mammæ supervene, and sometimes a viscid or serous fluid distills from the nipple; circumstances that strongly confirm the woman in her opinion, till time, or the dreadful consequences that often ensue, at last convince her of her fatal mistake.

False Conception.—Mola. Other kinds of spurious gravidity, less hazardous in their nature than any of the preceding, may under this head also be classed; diseases commonly known by the names of *false conception* and *mola:* The former of these is nothing more than the dissolution of the fœtus in the early months; the placenta is afterwards retained in the uterus, and from the addition of coagula, or in consequence of disease, is excluded in an indurated or enlarged state; when it remained for months or longer, and came off in the form of a fleshy or schirrous-like mass, without having any cavity in the centre, it was formerly distinguished by the name of *mola*.

Mere coagula of blood, retained in the uterus after delivery, or after immoderate floodings at any period of life, and squeezed, by the pressure of the uterus, into a fibrous or compact form, constitute another species of mola, that more frequently occurs than any of the former. These, though they may assume the appearances of gravidity, are generally however expelled spontaneously, and are seldom followed with dangerous consequences.

Superfœtation.

Chap. III. *Superfœtation.*

Soon after impregnation takes place, the cervix uteri becomes entirely shut up by means of a thick viscid gluten: the internal cavity is also lined by the external membrane of the ovum, which attaches itself to the whole internal surface of the fundus uteri· the fallopian tubes also become flaccid; and are, as gravidity advances, supposed to be removed at such a distance, that they cannot reach the ovaria to receive or convey another ovum into the uterus. For these, and other reasons, the doctrine of *superfœtation* is now pretty generally exploded.—A doctrine that seems to have arisen from the case of a double or triple conception, where, some time after their formation in utero, one fœtus has been expelled, and another has remained; or after the extinction of life at an early period, one or more may be still retained, and

thrown

Monsters. thrown off in a small and putrid state, after the birth of a full-grown child.

The uterus of brutes is divided into different cells; and their ova do not attach themselves to the uterus so early as in the human subject, but are supposed to receive their nourishment for some time by absorption. Hence the os uteri does not close immediately after conception; for a bitch will admit a variety of dogs while she is in season, and will bring forth puppies of these different species: thus it is common for a grey-hound to have, in the same litter, one of the grey-hound kind, a pointer, and a third, or more, different from both; another circumstance that has given rise to *super-fœtation* in the human subject, which can *only* happen when there is a double set of parts, instances of which are very rare.

Chap. IV. *Extra-uterine Fœtuses, or ventral Conception.*

The impregnated ovum, or rudiments of the fœtus, is not always received from the ovarium by the tuba Fallopiana, to be thence conveyed into the cavity of the uterus; for there are instances where the fœtus sometimes remains in the ovarium, and sometimes even in the tube; or where it drops out of the ovarium, misses the tubes, and falls into the cavity of the abdomen, takes root in the neighbouring parts, and is thereby nourished: But as these fœtuses cannot there receive so much nourishment as in the succulent uterus, they are less, and generally come to their full growth before the common term.

Of these some burst in the abdomen; and others form abscesses, and are thereby discharged; others dry, and appear bony, and remain so during life, or are discharged as above, or by stool, &c.

Chap. V. *Monsters.*

When two or more ova contained in the uterus attach themselves so near one another as to adhere in whole or in part, so as to form only one body with membranes and water in common, this body will form a confused irregular mass called *monstrous*; and thus a monster may be either defective in its organic parts, or be supplied with a supernumerary set of parts derived from another ovum. This seems a rational conjecture; but, while every thing relative to generation is a mystery, how can we account for the extraordinary phænomena? Some authors enumerate a third species of monster, the product of a mixed breed, exemplified, for instance, in the mule, produced by the mixed generation of an ass and a mare. In this animal there are organical parts different from what preexisted in the parents; there is a defect of some parts, a luxuriant growth of others; and the defect in the parts of generation, which renders the animal unfit for propagation, constitutes a very curious and particular species.

Chap. VI. *Diseases of Pregnancy.*

After conception, a remarkable change is soon produced in the genital system. This is the source from whence arise different symptoms, that are however liable to considerable variation, not only in the constitution of different women, but in the same woman in different pregnancies, and at different periods of the same pregnancy. Diseases.

Pregnancy,—though a natural alteration of the animal-œconomy, which every female seems originally formed to undergo, and hence not to be considered as a state of disease, occasions, however, sooner or later, in many women, various complaints, which evidently depend on it as a cause.

Diseases incident to the pregnant state may be considered, either, 1. As arising from sympathy in the early months; or, 2. As depending on the stretching and pressure of the uterus towards the more advanced stages.

I. Though the former of these complaints are generally to be accounted for from other causes than that of plethora; yet, in many constitutions, a certain plethoric disposition in the early months of pregnancy seems to prevail in the vascular system: And therefore, though many inconveniencies may ensue from a too frequent, a too copious, or an indiscriminate use of venesection; yet, if prudently and judiciously employed, abortion by this means will not be endangered, as some late authors have alleged; but, on the contrary, on many occasions, a seasonable bleeding will be attended with the most beneficial and salutary effects.

In young women, suddenly affected with severe sickness and loathing, febrile commotion, head-ach, vertigo, and other symptoms of breeding, more especially in full sanguineous habits, besides a spare light diet and suitable exercise, recourse must be had to proper evacuations, the chief of which is venesection: this may be safely performed at any term of gravidation, and occasionally repeated according to the urgency of the symptoms: small breedings, at proper intervals, are preferable to copious evacuations, which in early pregnancy ought always to be carefully guarded against.

When the stomach is loaded with putrid bile or acrid saburra, the offensive matter should be discharged by gentle vomits of ipecacuan, or of infusions of chamomile flowers. The violent efforts to retch and vomit, and the commotions thence excited, which often occasion the expulsion of the fœtus, will by this means frequently be removed, in most cases greatly diminished. During the term of breeding, the state of the belly must be also attended to: When laxative medicines become necessary, those of the mildest and gentlest kind should be administered.

In women liable to nervous complaints, where the stomach is weak, and the sickness violent and continued, the patient should be put on a course of light, aromatic, and strengthening bitters; such as infusions of bark, columbo, &c. and her diet, air, exercise, company, and amusement, should be regulated: In order to settle the stomach, and lessen the sensibility of the system, opiates will often happily succeed, when every other remedy fails.

Heart-burn and *diarrhœa*,—common symptoms of breeding, or of pregnancy, must be treated pretty much as at other times: Both complaints chiefly depend on the state of the stomach.

Tumefaction, *tension*, and *pains* in the *mammæ*.—If tight lacing here be only avoided, and the breasts have room to enlarge and swell, no inconvenience ever follows:

Diseases of Pregnancy.

follows: These effects arise from a natural cause, and seldom require medical treatment. If very troublesome and uneasy, bathing with oil, or anointing with pomatum, and covering with soft flannel or fur, will in most cases prove the cure.

The *menstrual evacuation*—is in some women regular for the first, second, or third period after conception. This seldom happens but in women of sanguinary plethoric habits, such as have been accustomed to large copious evacuations at other times, when the discharge is to be considered as beneficial.

Deliquia, nervous, or *hysteric fits*.—When these are occasioned by falls, frights, and passions of the mind, they frequently end in the loss of the child: But when they happen about the term of quickening, they seem to arise from the escape of the uterus from its confinement within the capacity of the pelvis; in which case they are commonly slight, of short duration, and never threaten any dangerous consequence.

II. The second class of complaints, viz. those that are incident to the advanced stages of utero-gestation, and that depend on the change of situation of the gravid uterus, its enlargement and pressure on the neighbouring parts, are more painful in their symptoms, and more dangerous in their consequences, than those enumerated in the preceding class. The premature exclusion of the fœtus is generally the worst inconvenience resulting from the *one*; the death of the mother, along with the loss of the child, is too frequently an attendant of the *other*.

Difficulty or *suppression* of *urine*—is sometimes occasioned by the pressure of the uterus on the neck of the bladder, before the fundus uteri escapes from its confinement within the brim of the pelvis. This complaint, if early attended to, will seldom prove troublesome or hazardous; but cannot be entirely removed till the uterus rises above the brim of the pelvis, and by its enlargement becomes supported by resting on the expanded bones of the ossa ilia. But if neglected in the beginning,

A retroversion of the uterus—is generally the consequence, a case that demands particular attention. Here the fundus uteri, instead of being loose, falls back in a reclined state within the hollow of the os sacrum: thus a tumor is formed in the vulva, whereof the os tincæ makes the superior part; the body of the uterus, by this means, becomes strongly wedged between the rectum and bladder; and, from the enlargement of the uterus itself, and accumulating load of fæces and urine, the reduction will prove in many instances utterly impracticable. A total suppression of urine, or a rupture of the coats of the bladder, fever, inflammation, or gangrene of the uterus, often ensue; and these are succeeded by delirium, convulsions, death.

The indications of cure, in this dangerous disease, are sufficiently obvious: For, in the first place, every obstacle that prevents the reduction should be removed: thus the contents of the rectum and bladder must, if possible, be evacuated; emollient fomentations and cataplasms must be applied, if indicated by inflammation or tumefaction of the parts. Secondly, The reduction of the prolapsed uterus must be attempted, by placing the patient upon her knees, with her head low and properly supported. While this is attempted within the vagina, a finger or two should also be passed within the rectum, by which the operation in some cases may be facilitated: but, at other times, no power whatever will be sufficient for this purpose. Lastly, If the reduction be accomplished, the fever, inflammatory symptoms, and other consequences of the disease, must be subdued; and a recurrence prevented by an open belly, rest, and recumbent posture, and promoting a free discharge of urine: means that ought to be persisted in till the uterus rises within the abdomen, when the patient will be secured from future danger.

Costiveness in pregnancy—is inconvenient. It may proceed from the same cause with the preceding complaint; it may depend of the stomach; the febrile heat, that in many women prevails, will also prove an occasional cause. It may be obviated or prevented by a proper regulation of the regimen, and by such gentle laxative medicines as are best suited to the state of the woman; the chief of which are ripe fruit, magnesia, lenitive electuary, cream of tartar, sulphureous and aloetic medicines, oleum ricini, emollient glysters.

The piles—frequently arise in consequence of costiveness, or from pressure of the gravid uterus on the hæmorrhoidal veins. These are also to be removed or palliated by the same means employed on other occasions; regard being had to this distinction, which may be applied universally to the gravid state, that all violent remedies are to be avoided: a light diet should be enjoined; the belly should be kept moderately open; and topical liniments or cataplasms should be applied, such as Bals. sulphur. Bals. traumaticum, Liniment. ex ol. palmæ, Ung. sambucin. cum laud. liquid. Poultices of bread and milk with opium, &c. according to the various circumstances of the case.

Oedematous swellings of the legs and *labia*,—are occasioned by the languid state of the circulation, by the interruption of the refluent blood from the pressure of the distended uterus on the vena cava, &c. These, though very troublesome and inconvenient, are seldom however of dangerous consequence, except where the habit is otherwise diseased; and seldom require puncture, as the swelling generally subsides very quickly after delivery. They can only, therefore, at this time, admit of palliation; for which purpose, along with a proper diet and moderate exercise, a frequent recumbent posture, open belly, and dry frictions applied to the legs evening and morning, will prove the most effectual means.

Varicous swellings in the legs and thighs—from the interruption of the venal blood in these parts, occasioned by the pressure of the gravid uterus, are to be treated in the same manner with the preceding complaint.

Pains in the back, loins, cholic-pains, cramp,—occasioned by the stretching of the uterus and appendages, and from the pressure of the uterus on the neighbouring parts, symptoms that are most troublesome in a first pregnancy, are to be palliated by venesection, an open belly, and light spare diet. If the patient be of a full habit, and pre-disposed to inflammatory complaints, where the pressure is very great in the advanced months, or in twins, &c. if proper

proper remedies are neglected, inflammation of the uterus and adjacent viscera, or dreadful epileptic fits, may quickly ensue; the event whereof is generally fatal. Crampish spasms in the belly and legs require the same palliative treatment; to which may be added friction, and the application of æther, ol. volatil. balf. anodyn. or the like, to the parts affected.

Cough, dyspnœa, vomitings, difficulty or incontinency of urine, occasioned by the pressure of the bulky uterus on the stomach, liver, diaphragm, &c.—Complaints that can only be alleviated by frequent small bleedings, a light spare diet, and open belly. The patient should be placed in an easy posture, something between sitting and lying; and when the uterus rises high, a moderate degree of pressure from the superior part downwards, may in in some cases prove useful. But this must be used with great caution; for dreadful are the effects of violent pressure, or tight lacing, during pregnancy. It frequently kills both mother and child, and ought to be guarded from the earliest months.

Epileptic fits,—are a very dreadful and alarming appearance. They generally depend on the same cause with the above complaints: they may also arise from irritation, excited by the motion and stirring of the fœtus; and from various other causes. Such as have had convulsions when young, are most liable to have them during pregnancy: they happen most frequently in first pregnancies, or where the fœtus is very large, or in twins, triplets, &c. In such cases, the distention of the uterine fibres is so great, that actual laceration is sometimes the consequence.

At whatever period of pregnancy they seize, the utmost danger may be dreaded. This, however, will be in proportion to the severity, duration, and recurrence of the paroxysm, to the term of gravidation, to the constitution of the patient, and her condition during the remission. The danger is greater towards the latter end of pregnancy than in the earlier months or in time of labour.

Such as arise from inanition, from excessive and profuse hæmorrhages, from violent blows, falls, &c. or from a ruptured uterus, are for the most part fatal.

Hysteric or nervous spasms must be carefully distinguished from true epileptic fits. The former are milder than the latter; they are not attended with foamings; they do not affect the posture; the pulse is smaller, feebler, and more frequent; the woman is pretty hearty after they are over; they are followed with no bad consequences, and yield to the common treatment. Women of strong, robust, vigorous constitutions, are more generally the subjects of the *one*; the delicate, the nervous, and the irritable, of the *other*.

Epileptic fits generally come on very rapidly; if any previous symptoms occur, the fit is commonly announced by an intense pain in the scrobiculum cordis, or violent head-ach.

In the pregnant state, these fits are for the most part symptomatic, and will therefore only admit of a palliative cure. They may be distinguished into three classes; those of the early months, those of the latter, and those that come on with labour-pains.

With regard to the cure, the term of pregnancy, as well as the constitution of the patient, and particular cause of the disease, must carefully be considered.

1. Convulsions at an early period of pregnancy chiefly happen to young women of a plethoric sanguine habit; and can therefore only be removed or palliated by a free and bold use of the lancet, by an open belly, cool regimen, and spare diet. After plentiful evacuations, if the stomach be loaded with acrid saburra or putrid bile, a gentle puke may be of use: but such remedies, on those occasions, must be employed with great caution. Instead of a plethoric, if the patient is of a nervous habit, a very necessary and important distinction, the intentions of cure will essentially vary. For here opiates in large doses and frequently repeated, emollient glysters, stupes applied to the legs, the semicupium, and every other means to soothe the nerves and remove spasmodic stricture, will prove the most effectual remedies. If insensible or comatous, opium, musk, and other antispasmodics, should be exhibited by way of glyster, and the patient ought to be roused by epispastic and stimulating cataplasms applied to the legs and hams. Convulsions succeeding profuse evacuations, are generally mortal. The vis vitæ, in such circumstances, must be supported, by replenishing the vessels with the utmost speed: this is to be done by pouring in nourishing fluids as fast as possible by the mouth, and by glyster; warm applications should also be made to the stomach and feet, and nervous cordials given internally along with opium.

The treatment of epileptic fits, depending on other causes than those now mentioned, must be regulated by a proper attention to the particular symptoms with which they are attended.

2. In the advanced months, such complaints are more to be dreaded than in early gestation, as they generally proceed from the irritation occasioned by the distention of the uterine fibres, or by the pressure of the uterus on the contiguous viscera: hence the natural functions of these parts will be interrupted, the circulation of their fluids will be impeded, and the blood, being thus prevented from descending to the inferior parts, will be derived in greater proportion to the brain, and overcharge that organ.

The cure must, in this case, chiefly rest on copious and repeated bleedings, an open belly, and spare diet.

3. Lastly, when fits come on with labour-pains, a speedy delivery, if it can be done with safety, either by turning the child, or by extracting with the forceps when the head is within reach, will prove the most effectual cure

When the bladder is distended, the contents must be evacuated: if a stone sticks in the urethra, it must be pushed back or extracted. If the fits are the effects of a ruptured uterus, immediate death is generally the consequence.

With regard to the treatment of such complaints, no other change is generally requisite, than what arises from the symptoms peculiar to this situation. In general, till after delivery, they will only admit of palliation.

CHAP. VII. *Floodings*.

THESE, tho' confined to no particular term, may hap-

Diseases.

pen at every period of gravidation. The one is a frequent consequence of the other; the event of both is often hazardous, as the earlier miscarriages are generally preceded by an effusion of blood from the uterus, which, in the advanced stages of pregnancy, besides the loss of the child, always endangers the life of the mother.

The *menorrhagia gravidarum*—may be defined, an effusion of blood from the uterus, confined to no regular or stated periods, in quantity and duration various, and liable to recur on the slightest occasions.

The immediate cause is, a separation of some portion of the placenta or chorion from the internal surface of the uterus. Whatever occasions this separation may be considered as the remote cause, which, though various, may be reduced to

I. Those that affect the general system: as,

1. External accidents changing the state of the circulation.
2. Changes in the circulation from internal causes.
3. Debility.
4. Plethora.

II. Those that affect the uterus and placenta: as,

1. Direct affections.
2. Stimuli communicated from an affection of other parts.

With regard to the cure.—Though a flooding in some constitutions may happen, even in early gestation, and may remit and recur from time to time, and the woman go on to the end of her reckoning; and tho' it seldom or never happens, that this complaint proves mortal to the mother in the first five months of pregnancy; yet every appearance of this kind, even the slightest, is to be dreaded; as in the early months it will often throw off the fœtus, and, in the latter, always threatens the utmost danger both to mother and child. Floodings of gravid women we cannot propose radically to cure; they will only admit of palliation. With this view, the indications are,

I. To lessen the force and velocity of the blood in general.

II. To promote the constriction of the patulous mouths of the bleeding vessels, or the formation of coagula in their orifices.

1. To answer the first indication, rest and a recumbent posture, cool air, tranquillity of mind, a light diet, venesection, and opiates, are the chief means.

2. To restrain the violence of the hæmorrhage, internal astringent medicines are recommended; but this is to be accomplished chiefly by means of cold styptic applications to the parts and their neighbourhood. But, as these floodings often arise from so various and opposite causes, it is difficult to lay down particular indications, or to point out a method of cure suited to every case that may occur. The intention of cure can only be regulated by a careful and judicious consideration of the cause, and of those particular circumstances with which the case may be attended. In early pregnancy, it may be restrained by keeping the patient quiet and cool, by giving internally cooling things and opiates; but, in the advanced stages, the deluge is sometimes so profuse as to kill very suddenly. Under such circumstances, when the woman is near her time, emptying the uterus by delivery, if practicable, is the only safe expedient both for preserving the life of the mother and of the child.

Abortion.

If the hæmorrhage can be restrained, a recurrence must be guarded against, by avoiding or counteracting the occasional or remote causes.

Chap. VIII. *Abortion, or Miscarriage,*

May be defined, the premature expulsion of the embryo or fœtus. Some, however, make the following distinction: When a woman miscarries in early gestation, this they consider as an abortion; but if in the latter months, that they term a *premature birth*. The symptoms that threaten abortion are:

Flooding.
Pain in the back and belly.
Bearing down pains with regular intermissions.
The evacuation of the waters.

The death of the child, which discovers itself by the following symptoms; though in general these are so doubtful and fallacious, that none of them afford an infallible sign:

1. The subsiding of the abdominal tumour.
2. Cessation of motion in the fœtus.
3. The sensation of a heavy weight falling from side to side, as the woman turns herself in bed.
4. Sickness, faintings, rigors, cold sweats.
5. The breasts turning flaccid.
6. Coldness of the abdomen, and putrid discharge from the vagina.

Abortions are seldom dangerous in the first five months; but a frequent habit of miscarriage debilitates the system, shatters the constitution, and lays the foundation of chronic diseases of the most obstinate and dangerous nature.

In the advanced months, the prognosis will be more or less favourable, according to the patient's former state of health, the occasional cause, and symptoms with which it is attended. The proximate cause of abortion is the same with that of true labour, *viz.* a contracting effort of the uterus and abdominal muscles, assisted by the other expulsive powers. The remote causes cannot be explained with precision; as many circumstances, with regard to the nature of impregnation, and connection of the fœtus with the placenta and uterus, are subjects still involved in darkness. They may in general, however, be reduced,

I. To whatever interrupts the regular circulation between the uterus and placenta.

II. To every cause that excites the spasmodic contraction of the uterus, or other assisting powers.

III. To whatever occasions the extinction of life in the fœtus.

Amongst the first are:

1. Diseases of the uterus.
2. Imperviousness or spasmodic constriction of the extremities of the uterine blood-vessels.
3. Partial or total separation of the placenta or chorion from the uterus.
4. Determination to other parts.

To the second general head belong all causes that produce a strong contraction of the elastic fibres of the uterus, or of the parts that can press upon it, or that occasion a rupture of the membranes; such as,

1. Violent agitation of mind or body.
2. A disease of the membranes.
3. Too large a quantity of liquor amnii.

4. The

Abortion.

4. The crofs pofition of the fœtus.

5. Its motion and kicking.

The laft head includes the numerous caufes of the death of the child, which, befides thofe referred to in the preceding claffes, may be occafioned by,

1. Difeafes peculiar to itfelf.
2. Difeafes communicated by the parents.
3. External accidents happening to the mother: or,
4. Accidents incident to the fœtus in utero.
5. Difeafes of placenta or funis.
6. Knots and circumvolutions of the chord.
7. Too weak an adhefion of placenta or chorion to the uterus: and,
8. Every force that tends to weaken or deftroy this attachment.

With regard to the treatment. This muft be varied according to the particular circumftances of the cafe: nor is it poffible to point out particular indications, or propofe any regular plan to be purfued for this purpofe. Abortion is often preceded by no apparent fymptom, till the rupture of the membranes, and evacuation of the waters, announce the approaching expulfion of the fœtus. Either to remove threatening fymptoms, or to prevent mifcarriage when there is reafon to apprehend it, often baffles our utmoft fkill; becaufe it generally happens, that there is a ceffation of growth in the ovum; or, in other words, an extinction of life in the fœtus, fome time previous to any appearance of abortion. For inftance, in early geftation, a woman commonly mifcarries about the 11th or 12th week; but the age of the fœtus at this time is generally no more than eight weeks. At other times, when by accident the fœtus perifhes, perhaps about the fifth or fixth month, it will ftill be retained in utero, and the expulfion will not happen till near the completion of full time.

As women who have once aborted are fo liable to a recurrence from a like caufe, at the fame particular period, fuch an accident, in future pregnancies, fhould therefore be guarded againft with the utmoft caution. On the firft appearance of threatening fymptoms, the patient fhould be confined to a horizontal pofture; her diet fhould be light and cooling; her mind fhould be kept as tranquil as poffible; a little blood from the arm may be taken occafionally; and opiates adminiftered according to circumftances; but excepting fo far as depends on thefe, and fuch like precautions, for the moft part, in the way of medicine, very little can be done.

Manual affiftance is feldom or never neceffary during the firft five months of pregnancy: the exclufion of fœtus and placenta fhould very generally be trufted to nature.

The medical treatment of abortion muft therefore be confidered with a view only to the prophylactic cure: and this again will chiefly confift in a proper

Chap. IX. *Regimen during Pregnancy.*

Regimen.

Women, when pregnant, fhould live a regular temperate life; moderation in eating and drinking fhould now be very carefully obferved, and every thing that has any tendency to difagree with the ftomach fhould be avoided; otherwife the manner of life fhould be much as ufual. If complaints do occur, thefe fhould be treated as at other times; only guarding againft fuch things as, by violent operation, may endanger mifcarriage. If the woman has formerly been fubject to this accident, the caufe fhould be carefully confidered, and fuitable remedies applied; if plethoric, for inftance, fhe fhould be blooded, live fparingly, and keep quiet, till fhe gets beyond the dangerous period. If fhe be weak, delicate, and nervous, bark, light aromatic bitters, mineral waters, and the cold bath (if able to bear it), will prove the beft prophylactic remedies. The cold bath has, in many cafes, cured the moft obftinate fluor albus, and fometimes even fterility itfelf; and, in relaxed habits difpofed to mifcarriage, when every other means has failed, the cold bath has done confiderable fervice: the practice may fafely be continued for fome months after conception, when it has been early begun, or when the patient has been accuftomed to it. Such a fhock will, however, act very differently on different fyftems: hence, it is an expedient by no means to be indifcriminately ufed in the pregnant ftate.

Abortions that happen in early geftation, and that come on fuddenly without any prefaging fign, if ever they are to be prevented, it can only be done by avoiding all occafional caufes, by counteracting morbific difpofition, and by confinement to a horizontal pofture, for fome time before, and till the critical period be over.

When a venereal taint in the parents is fufpected to be the caufe either of abortion or the death of the fœtus, the like accident can only be prevented by putting both parties on a mercurial courfe.

Pregnant women require a free pure air; their amufement fhould often be varied; their company fhould be agreeable and cheerful; their exercife fhould be moderate, and fuited to their inclination, conftitution, and the feafon; they fhould avoid crowds, confinement, travelling over rough roads in a carriage, or being expofed to fea-voyages. Riding a-horfeback fhould alfo be practifed with great caution, that difagreeable objects may be fhunned, and fhocks of every kind prevented. For this reafon, when riding is judged proper, the woman fhould be a courageous rider; fhe fhould never ride without fomebody being in company; the horfe fhould be tame and well trained; the road fhould be fmooth as well as private; and the exercife fhould be gentle and eafy, and never carried the length of fatigue. Women fhould, with the utmoft care, guard againft confining the breafts or belly; early recourfe fhould be had to jumps, and they fhould keep themfelves as loofe and eafy as poffible through the whole term of utero-geftation. An open belly is neceffary and important in the pregnant ftate; it keeps the ftomach in good condition, prevents cholics and other complaints that may terminate in mifcarriage. When the abdomen is pendulous towards the latter months, a gentle fupport by proper bandage will prove ufeful; and the woman, when fatigued, fhould occafionally, through the day, indulge in reft on a bed or couch.

LABOURS.

Labours are divided into three claffes: *natural*, *laborious*, and *preternatural.*

In whatever manner the head of the child prefents, where the delivery at full time is performed by nature, the labour is with great propriety called *natural;* when the

Natural Labour.

the birth is protracted beyond the usual time, or cannot be accomplished without extraordinary assistance, it is deemed *laborious*; and *preternatural*, when any other part but the head presents.

Chap. X. *Natural Labour.*

By whatever power the uterus is enlarged, when any further increase is prevented, a stimulus to contraction must ensue; by this means an uneasy sensation is excited, which must, in the woman, produce an effort to procure relief: and thus arise the true labour-pains, which at first are slight and of short duration, a considerable remission intervening: the periods of recurrence soon become more frequent; the pains acquire an increased force, producing more and more change on the os uteri; which, yielding to the impelling cause, gradually opens and expands; till at length it becomes completely dilated, the membranes protruded and ruptured, and the child, by the expulsive force of the uterus, assisted by that of the diaphragm and abdominal muscles, is thus pushed along and delivered.

The symptoms of approaching labour are, The subsiding of the abdominal tumour: hence a discharge of mucus from the vagina, sometimes tinged with blood; incontinency, or suppression of urine; tenesmus; pains of the belly, loins, and about the region of the pubes; restlessness, hot and cold fits, &c.

Spurious pains are to be carefully distinguished from those of genuine labour. The former arise from the stretching of the uterus and its pressure on the neighbouring parts, or from costiveness; and are to be distinguished from the latter by the following symptoms: They are most troublesome towards the evening, increase in the night, and abate through the day; they are more trifling and irregular than true uterine pains; the uterine orifice is not affected; and there is no increased flow of mucus from the parts.

True pains begin about the region of the kidneys, strike forward towards the pubes, and down the thighs: they return at regular periods: there is a copious discharge of mucus from the vagina; the os uteri gradually opens, and can be felt to dilate in time of a pain; while the membranous bag, in a tense state, forcibly pushes against the finger.

The event of labours is so precarious, that no certain judgment can be formed from almost any symptoms, till the labour itself be considerably advanced. A prognosis in general is chiefly to be formed from the age, state of health, and temperament of the patient; from the force, duration, and recurrence of the pains; and from their effect on the uterine orifice; from the time of the rupture of the membranes; from the general make and form of the woman, but, in particular, of that of the pelvis; from the bulk and position of the child, &c.

With regard to the method of delivery, and position of the woman, this has been different at different ages, and in different countries: the chief thing, however, is to guard against cold and fatigue, observing that the woman be placed in the most favourable posture for supporting the back, for the action of the abdominal muscles, &c. and most convenient for the necessary assistants: till the labour is considerably advanced, she may be indulged in whatever posture is most agreeable; after which the bed or couch is the most proper.

Natural Labour.

With regard to assistance in natural parturition, the accoucheur for the most part has little to do, till the membranes are ruptured, and the head in perinæo. In time of labour, the woman should be kept very cool, and every means of being overheated should be avoided. She should be put to bed in proper time, placed on her side or back, with her head and shoulders a little raised, a cloth tied to the bed-post, or held by an assistant, to support her hands in time of pain, and her feet resting against a foot-board; her knees should be drawn up towards the belly, and a folded pillow put between them. All efforts to press or strain, except what nature excites, are improper, hurtful, and should be avoided: the membranes, if possible, ought not to be ruptured till they almost protrude at the os externum: the perinæum must be lubricated when formed into a tumour, and carefully supported while overstretched; for this purpose, a cloth smoothly folded should be applied over the part, to enable the accoucheur to have a firmer hold. This is an important part of his office; and must be attended to with the strictest care. From the time this protrusion begins to form till the head of the child be completely delivered, the perinæum must be carefully preserved by the palm of the hand firmly applied against it, which should be carried backwards in a direction towards the anus, and kept so during every pain. Thus the miserable consequences will be prevented to which the neglect of this pressure exposes: for by this support the overstretching of the perinæum will be greatly lessened, the parts will dilate gently and gradually, the vertex will easily slip from under the pubes, and the fore-head will rise from under the perinæum in a safe, slow, and gentle manner. The perinæum must now be released, by cautiously sliding it over the face and chin of the child; and this ought to be made further sure of, by passing a finger under it round and round. After the head has thus mechanically advanced through the pelvis and vagina, a pain or two must be waited for, when in like manner the body will follow; nothing more being necessary than to support the child while it is gradually pushed forwards by the expulsive force of the natural pains.

When the child has cried, and the change in the circulation freely taken place, the funis umbilicalis must be tied and divided, the infant must be wrapped in a warm receiver, and given to the nurse to be washed and dressed.

The parts of the woman must now be gently wiped, a warm soft cloth must be applied, and a proper time waited for the separation of the placenta.

This is also the work of nature, and seldom requires more force to bring it along than if it lay entirely loose within the cavity of the uterus. Thus, in pulling, no greater force should be employed than is just sufficient to put the funis on the stretch: for if it is already separated, no violence is necessary to extract it; and if the adhesion is very firm, all violent efforts are improper, and often followed with most dangerous consequences. Its advancing is known by the contraction of the uterus, and shifting of the abdominal tumour, and by the lengthening of the cord. By the spontaneous contraction of the uterus, this separation is effected; the expulsion will be slower or more expeditious,

ditious, according to the ſtate and condition of the woman, according to the number of children ſhe has born, and according to the duration or violence of the labour; it is eaſier and ſooner ſeparated in a firſt birth, when the woman is in good health, and when the labour has been properly managed. In moſt caſes, this ſeparation is accompliſhed within half an hour after the delivery of the child. It adheres moſt firmly after premature births, when the woman has been ſickly during pregnancy, where the labour has been tedious and difficult, or when haſty attempts have been made to extract it. A finger, or finger and thumb, guided by the funis, and introduced within the vagina, to bring down the edge, will remove any difficulty occaſioned by the centre or bulky part paſſing the uterine or vaginal orifice.

When it becomes neceſſary to employ force in extracting the placenta, which is never requiſite but in caſes of flooding, when the woman has been in bad health during pregnancy, when ſhe has ſuffered much in time of labour, or when the ſtring has been torn from it, (though the firſt of theſe caſes is perhaps the only one wherein the practice is abſolutely proper), the method of doing it is as follows: In ordinary caſes, the woman ſhould be laid on her back or ſide; but when the belly is pendulous, or when the placenta is attached to the fundus uteri, ſhe muſt be placed on her knees, which is the moſt convenient poſture.

The acoucheur, though with a certain degree of courage, yet with the utmoſt poſſible tenderneſs, muſt then paſs his hand well lubricated through the vagina into the uterus, and feel for the convex body of the after-birth; if the chord be entire, this will direct him; if not, he muſt feel for the looſe membranes at the edge of the cake; and muſt not be deceived by coagula of blood that lie in the way: if the uterus be conſtricted in the middle like a ſand-glaſs, a circumſtance that ſometimes, though rarely, occurs, this muſt be overcome by a gradual dilatation with one finger after another, till the whole hand in a conical manner can ſafely be paſſed. He muſt not content himſelf with feeling a part; he ſhould be able to move his fingers round the whole body of the cake; the adheſion muſt be ſeparated very gradually, in a direction from the ſides round and round. The placenta is diſtinguiſhed from the uterus, as well by its ſoftneſs as by its convex puckered feel. This convexity increaſes in the ſame proportion as the uterus contracts: hence the middle part or centre of the placenta is firſt detached; and if the edges are carefully ſeparated, by gently paſſing the fingers behind, the whole body becomes looſe and diſengaged, which muſt now be brought along with great caution, that no part be left behind, and that no injury be done to the woman in making the extraction.

Though bad conſequences ſometimes follow from the retention of the placenta, yet it is much to be queſtioned, if theſe are not leſs to be dreaded than the dangerous floodings, convulſions, deliquia, inflammation of the uterus, fever, &c. that may be induced from the prepoſterous practice of paſſing the hand to make the extraction: and would it not in general be better to confine the practice of introducing the hand, to caſes of uterine hæmorrhages only? Where the adheſion is ſo firm as to require force, or where its place of attachment is out of the reach of the finger, by which, for the moſt part, the edge may be brought down, is it not by far the ſafeſt and the moſt rational practice univerſally to truſt to nature? Should the mouth or body of the uterus become conſtricted before the ſeparation is effected, no matter; little is to be dreaded: it will afterwards kindly dilate; and the ſeparation and expulſion will ſpontaneouſly be accompliſhed with as much ſafety as in other animals, where no force is ever uſed. Let every candid practitioner acknowledge, that for one inſtance where the retention of the placenta has been attended with dangerous conſequences, a precipitate or forcible extraction has proved fatal to hundreds.

After the delivery of child and placenta, the woman muſt reſt a few minutes; her ſtrength and ſpirits may be recruited by ſome light nouriſhing cordial; the wet cloths, &c. muſt then be removed; the bed muſt be properly ſhifted and adjuſted; and a gentle compreſſion muſt be made on the abdomen.

During lying-in, the woman ſhould avoid company and noiſe; her dreſs and bed-linens ſhould be often changed; ſhe ſhould avoid every means of being overheated; and with regard to her diet, it ſhould, for the firſt week at leaſt, be very light and of eaſy digeſtion.

Chap. XI. *Laborious or difficult labour.*

When the birth is protracted beyond the ordinary time, or when the child's head, though naturally preſenting, cannot be brought forwards without aſſiſtance, the labour is accounted difficult or laborious.

Though the cauſes of laborious births are various and complicated, they may in general be conſidered as depending,

I. On the mother.
II. On the child.
III. On the ſecundines.

I. The birth may be protracted, or the labour-pains interrupted, by,
 (1.) Debility in the mother, ariſing,
  a From diſeaſe, *viz.*
   1. Flooding.
   2. Epileptic fits.
   3. Crampiſh ſpaſms.
   4. Lowneſs and faintiſhneſs.
   5. Inflammatory diatheſis.
   6. Colic.
   7. Nauſeating ſickneſs and vomiting.
   8. Hectic or conſumptive habit.
  b From paſſions of the mind.
  c From miſmanagement in time of labour.
 (2.) Local complaints in the parts, or their neighbourhood, *viz.*
  a In the bones, occaſioning narrowneſs and diſtortion.
  b In the ſoft parts, *viz.*
   1. Dryneſs and conſtriction of the vagina.
   2. Thickneſs and rigidity of the os tincæ.
   3. Scirrhous or polypous tumours about theſe parts.
   4. Accumulated fæces in the inteſtines.
   5. Stone in the urethra.
   6. Prolapſus of the uterus, vagina, and rectum.

7. Ob-

Natural Labour.

7. Obliquity of the uterus.

II. Difficulties alfo arife on the part of the child, *viz.*

1. From the bulk and offification of the head.
2. The fituation in which the head prefents.
3. Large broad fhoulders, or their tranfverfe defcent through the pelvis.

III. The fecundines, *viz.*

1. The rigidity of the membranes, and the contrary.
2. Too great a quantity of water.
3. The funis umbilicalis too long, or too fhort.
4. The prolapsus of the funis before the child's head: and,
5. The attachment of the placenta towards the cervix or os uteri.

The treatment of laborious births requires a very nice and careful attention to the condition of the patient and other circumftances, from whence only we can judge when affiftance becomes requifite, and how it may be applied to the beft advantage. That pain and mifery is the unavoidable and infeparable attendant of child-bearing, though dealt out in different proportions to different fubjects, the teftimony of all nations, and all ages, as well as daily experience, bear witnefs: nor is the eafieft labour altogether exempted from pain, even under the moft favourable circumftances. The delivery, however, promifes to be fafe and eafy, when the woman is of proper age, in good health, the child prefenting right, and the pelvis well proportioned: but the force of the natural pains may be interrupted, and of confequence labour be retarded, from,

I. Debility in the mother, arifing from

a Difeafe. This may appear under various forms; as,

1ft, A flooding. Which is very alarming, even along with labour-pains: though lefs fo in this cafe than when at a diftance from full time; becaufe as the labour-pains increafe, the hæmorrhage very generally abates; or if not, breaking the membranes when the aperture of the os uteri is fufficient to admit the hand, feldom fails to produce that effect. The woman in this cafe muft be kept cool. Opiates muft be adminiftered; fhe muft be comforted with the beft affurances of a happy delivery; and the natural pains muft be waited for.

But if the hæmorrhage proceeds from a feparation of the placenta, attached towards the cervix or orificium uteri; in this unhappy cafe, the whole body of the cake may be completely feparated before the aperture of the uterus be fufficient for allowing the head to pafs; and the deluge may be fo fudden and impetuous, that the woman will fink immediately under it. Breaking the membranes, and making the delivery, either by turning the child, or extracting with the forceps or crotchet, according to circumftances, with as much expedition as is confiftent with the mother's fafety, is the only expedient by which the threatening cataftrophe may be prevented.

2dly, Epileptic fits may in like manner retard labour, and endanger the life of the mother. If the child is not thrown off by a few fits, which is often the cafe, the delivery fhould be effected as foon as poffible.

3dly, Crampifh fpafms in the thighs, legs, rarely in the belly, are very troublefome. They depend on the preffure of the head on the nerves as it paffes through the pelvis, and can only be removed by delivery, which, as thefe pains are feldom, if ever, attended with danger, is not to be forced on this account. Breaking the membranes will fometimes remove them.

4thly, Lownefs and faintifhnefs often occur, and frequently prove the caufe of protracted labour.

No general rules with regard to the management of flow labour can be recommended. The mode of treatment, where fo many circumftances may occur, muft be fuited to the condition of the patient, as every particular cafe will in fome meafure require a different management. Much depends on the prudence and judgment of the attentive practitioner. For inftance, when the woman is nervous, low-fpirited, or weakly, from whatever caufe, in general her ftrength muft be fupported: fhe muft not be put on labour too early: fhe muft avoid heat, fatigue, and every means of exhaufting her ftrength or fpirits. When fhe is reftlefs, or the pains trifling and unprofitable, opiates are particularly indicated; they remove fpurious or grinding pains, recruit the fpirits, procure reft, and amufe time. Little elfe for the moft part is to be done. If the uterus once begins to dilate, though the dilatation goes on flowly, it is by much the beft and fafeft practice to do nothing but regulate the management as above. The pains at laft will become ftrong and forcing; and the delivery, even where the patient has been very weakly, will often have a fafe and happy termination. In thefe tedious labours, if the ftrength of the woman be properly fupported, every thing almoft is to be expected from nature. Forcible means fhould be the laft refource.

5thly, Inflammatory diathefis, in young fubjects of ftrong rigid fibres and plethoric habits, muft be obviated by venefection, an open belly, and cooling regimen.

6thly, Colic.—Many women have fevere attacks of this difeafe immediately before the labour-pains come on; the reafon of which is fufficiently obvious: the belly, which formerly rofe fo high, that the fundus of the womb preffed againft the pit of the ftomach, afterwards fubfiding, by the child's finking to the lower part of the womb, and the oval of the head being applied to the oval of the bafin, the contents of the inteftines will be forced lower and lower, and the ftrait gut will be diftended. Hence colic-pains, irritation, and uneafinefs, a frequent defire to go to ftool, or frequent loofe ftools, generally enfue. The beft palliative remedy is to inject emollient glyfters repeatedly till the bowels be entirely emptied. Although fome degree of purging fhould attend the tenefmus, it will be neceffary to wafh the ftrait gut, by the ufe of one or more glyfters. The irritating caufe being in this way removed, an opiate, if no inflammatory heat or fever prevents, may be afterwards given with advantage.

7thly, Naufeating ficknefs, with vomiting.—When thefe fymptoms occur, warm water or chamomile-tea muft be drunk freely. Ficknefs and vomiting happen in fome degree in the eafieft labours. Sometimes they proceed from a difordered ftate of the ftomach; but in general are to be accounted for from the well-

known

Difficult Labour.

known sympathy of the womb with the stomach; and accompany the stretching of the os uteri only.

8thly, Hectic or consumptive habit.—It is a melancholy thing to attend a labouring woman in this state. The pains are weak and trifling; she cannot force much down; and she is feeble, and liable to faint when the pain goes off. But however apparently exhausted, the progress of labour goes on, in most cases, much better than could be well expected. The orifice of the womb gives little resistance to the force of the pains, weak and trifling as they are; the parts are soft and lax, and soon stretch in such a manner, that, if there be no fault in the pelvis, the child readily obtains a passage.

Here little is to be done, but supplying the patient, from time to time, with light nourishment; with cordials that do not heat; and keeping up a free circulation of cool air all around her: for this purpose the curtains should be quite drawn aside, doors and windows widely opened; and she should be placed in a position with her head and breast well raised, that an easy respiration may be promoted. Hectic women under proper management rarely sink immediately after delivery; they generally survive a week, or longer, tho' they seldom outlive the month.

b. Passions of the mind. Any piece of news in which the patient, her family or relations, are interested, should be carefully concealed, as well as every thing that tends in general to affect the passions; as labour may not only be interrupted from this cause, but the most dangerous symptoms, as floodings, convulsions, deliquia, and fatal syncope, may be induced.

c. From mismanagement in time of labour often arises debility; so that the patient's strength is exhausted, the pains at length entirely cease, and the head of the child remains locked in the pelvis, merely from want of force of pain to push it forwards. In all cases where the labour has the appearance of being tedious, the woman's patience must, as much as possible, be supported. During the grinding pains, she must be kept cool and quiet; opiates may be exhibited to pass the time, till the forcing throes ensue, when she will acquire resolution, the parts will dilate kindly, and the labour end happily; whereas, if she considers herself in labour from the earliest appearance of grinding pains, she is frightened at the length of time, and her patience runs out. Slow lingering labours happen chiefly to elderly women having a rigidity in the parts, to nervous subjects, and to such as have been weakly during pregnancy. It is of great consequence, and the advice cannot be too much inculcated, to avoid exhausting the woman's strength too much at first.

2. *Local complaints in the parts, or their neighbourhood.*

a. Narrowness or distortion of the bones of the pelvis. Where there is any material defect in this cavity, a superficial knowledge of the form and structure of the parts will enable us to judge. If, from the figure of the woman's body, there is reason to suspect a faulty pelvis; if the spine is twisted, the legs crooked, the breast-bone raised, or the chest narrow; whether the pelvis be affected or not, she will require a particular management; for the constitution of such women is weak and feeble, and they cannot be much confined to bed on account of their breathing. We can never be absolutely certain of a distortion of the pelvis, (except when the distortion is confined to the inferior aperture), till the uterine orifice is considerably dilated. After this time, if the pains are strong and forcible, and the head of the child makes no advance, a narrow pelvis or large head is to be suspected. The pelvis may be faulty at the brim, bottom, or in the cavity or capacity. The first of these, which most frequently occurs, is the most difficult to be discovered. The second can be readily perceived by the touch: for we can feel the defects in the shape of the os sacrum and coccyx, in the position of the ischia, and in the bending of the pubes; and where the distortion is so general, that the whole cavity of the pelvis is affected, the shape of the woman's body, the slow progress of the labour, and the state of the parts to the touch, will afford sufficient information.

In the first case, we can only know the distortion by the symptoms; for we should not attempt to introduce the hand till the mouth of the womb be dilated: it is afterwards unnecessary; for we know that the pelvis is too small, or the head too large, by its not advancing in proportion to the pains, and by feeling a sharp ridge like a sow's back on the top of the child's head, which is occasioned by the bones rising over each other in consequence of the pressure.

How long nature, in such circumstances, can support the conflict, it is difficult to say. It is sufficient to observe, that when things are properly prepared for the advance of the child, when the first stage of the labour is accomplished, but its progress is then suspended, it is of little consequence to the midwife whether the obstacle is to be referred to the child, or to the mother; and a man-midwife ought to be immediately called in.

If the patient's strength declines; if the head, from being locked in the bones of the pelvis, begins to swell, and the parts of the woman to be affected with tumefaction and inflammation; nature, in this case, seems insufficient, and it will be dangerous longer to delay the proper means of making the delivery; as mother, or child, or both, may fall a victim to our neglect. We must not, however, allow ourselves to be imposed on, either by the impatience of the distressed mother, or by the clamours of the officious impertinents about her. In affording that assistance we are able to give, we are only to be directed by the symptoms of the case: we must remember that the gentlest assistance our hands or instruments in laborious births can afford, is always attended with hazard and risk; that if instruments be applied too early, nature will be thus interrupted in her work, and the most fatal consequences may ensue; and that if assistance be delayed too long, the mother may die undelivered: we ought, however, to be informed, that the former practice of having too early recourse to forcible means, where, in time, nature unassisted might do her business, has proved by far more fatal than the latter. We ought therefore carefully to consider the general history of the patient, and particular circumstances of the case, that we may hit the proper time of making the delivery; which, in these laborious labours, is exceedingly difficult to determine; yet is a matter of the utmost importance, as there is always one, often two or more lives at stake, and the accoucheur is accountable for the consequences of his mis-

Difficult Labour.

misconduct or neglect.

b. The fault may be in the soft parts: as,

1. Dryness and constriction of the vagina. Here all stretching and scooping is to be avoided. The natural moisture is to be supplied by lubricating with pomatum or butter, or by throwing up injections of warm oil; the parts are likewise to be relaxed by the application of warm stupes, or by warm steams directed to them.

2. Thickness and rigidity of the os tincæ. This happens chiefly in women well advanced in life, where the parts open more slowly, and the labour generally proves more tedious. Here also little is to be done but waiting on with patience, comforting the woman as well as possible, and giving an opiate from time to time. The parts may be relaxed with butter or pomatum, by throwing into the vagina injections of warm oil, or by the application of warm stupes to the os externum. Every forcible attempt to open or stretch the uterus, as some authors presume to advise, is apt to induce inflammation and its consequences, and to interrupt the natural pains: it is therefore universally the safest practice to trust in every case to these; tho' tedious, or even violent, the labour for the most part will end more happily, and the woman recover better, than if force had been employed.

3. Polypous tumours, &c.—There is seldom occasion, in case of cicatrices in the vagina, to dilate with the scalpel, to remove polypous tumors by excision, or to cut upon and extract a stone from the urethra in time of labour. But, if circumstances are urgent, such expedients are safe and practicable, and warranted by many precedents.

4. Accumulated fæces in the intestines, ought always to be removed by repeated emollient glysters, on the first appearance of approaching labour.

5. A stone in the urethra, if it cannot be pushed back, must be cut upon and extracted, as already advised.

6. Prolapsus of the uterus may happen even at full time, in a pelvis too wide in all its dimensions; for which, however, nothing can be done, but to support the uterus in time of a pain, that the stretching of the parts may be gradual. Prolapsi of the vagina and rectum must be reduced at the remission of the pain, and a return by gentle pressure must be prevented.

7. Obliquity of the uterus, though a favourite theory of some authors, never happens in such a degree as to influence delivery, except in the case of a pendulous abdomen, or where it depends on the make or distortion of the pelvis. The first of these, tho' it may, by throwing the child's head over the pubes, occasion perhaps some little delay, will seldom prove any material obstacle to the progress of the labour.

II. The protraction of labour may depend on the child, and may arise from,

1st, The bulk or ossification of the head.

There may be either a natural disproportion between the head and body, or the swelling may be occasioned by a putrid emphysema in consequence of the child's death, or the enlargement may proceed from a hydrocephalus. The first of these cases can only be discovered by the slow progress of the labour, when the pains are strong and frequent, the soft parts sufficiently dilated, the woman in good health, and no other apparent cause to account for the remora. The second is discovered from the history of the case, from the common symptoms of a dead child, viz. the puffy emphysematous feel of the presenting part of the head, and from the separation of the cuticle when touched. Lastly, the hydrocephalus is discovered by the head falling down in the pelvis in a large bulky form, by the bones of the head being separated at considerable distances, and by a fluctuation evident to the touch. On the whole, however, it may here be observed, that the most probable or suspicious symptoms of the child's death are often deceitful.

Difficult Labour.

From whatever cause the head is enlarged, if the difficulty arises from this cause, and the force of the pains prove insufficient to push the head forwards, recourse must be had to instruments; and, if the bulk of the head is too large to pass the diameter of the pelvis, the cranium must be opened to diminish its size, and the brain evacuated previous to the extraction.

2dly, The position of the head, which may be squeezed into the pelvis in such a manner as not to admit of that compression necessary for its passing. Such a cause of difficulty, however, more seldom occurs than many authors have imagined. The rash and preposterous application of instruments has, in such cases, proved the bane of thousands. Here though the labour will prove more painful and more tedious, yet nature in general, unassisted, will accomplish her own work with more safety to mother and child, than by the intrusion of officious hands. Turning here is always difficult, often dangerous. The same observation will hold of instruments, which should never be employed but when alarming symptoms occur: the assertion perhaps is not more bold than true, that, in general, the most disadvantageous position in which the head can offer is not sufficient, without some other cause concurring, either to prevent delivery, or to endanger the life of mother or child so much as would be done by the movement of the gentlest hands. Yet, in some cases, where the woman is weak and exhausted, and the pains trifling; if the head of the child be large, the bones firm, and the sutures closely connected; or if there by any degree of narrowness in the pelvis, a difficult labour is to be expected; and the life of both mother and child will depend on a well-timed and skilful application of the surgeon's hands.

The unfavourable position of the head may be referred to two kinds, which include a considerable variety. 1. When the fontanella, or open of the head, presents instead of the vertex. 2. Face-cases.

If no other obstacle appears but the presenting of the fontanella, the labour will, by proper management, generally end well; and much injury may be done by the intrusion of officious hands.

Face-cases are the most difficult and laborious of all kinds of births; and our success in these will chiefly depend upon a prudent management, by carefully supporting the strength of the woman. The varieties of face-cases are known by the direction of the chin; for the face may present, 1. With the chin to the pubes. 2. To the sacrum. 3. To either side. The rule in all these cases is to allow the labour to go on till the face be protruded as far down as possible. It is often as difficult and hazardous to push back the child, and to bring down the crown or vertex, as to turn the child,

Difficult Labour.

child, and deliver it by the feet. Sometimes a ſkilful artiſt may ſucceed in his attempt to alter the poſition, when he has the management of the delivery from the beginning; or, in thoſe caſes where the face is conſiderably advanced in the pelvis, may be able to give aſſiſtance by paſſing a finger or two in the child's mouth, and pulling down the jaw; which leſſens the bulk of the head; or, by preſſing on the chin, to bring it under the arch of the pubes; when the crown getting into the hollow of the os ſacrum, the head will afterwards paſs eaſily.

3dly, The breadth of the ſhoulders, or their tranſverſe deſcent through the pelvis, rarely proves the cauſe of protracted labour. The head is always pretty far advanced before any obſtruction can ariſe from this cauſe; and if the head has already paſſed, in a pain or two the ſhoulders will follow. The ſame reaſoning will alſo apply with regard to the aperture of the uterus itſelf: if the head paſſes freely, in like manner will the ſhoulders; the os uteri rarely, if ever, is capable of contracting upon the neck of the child, and thus preventing the advance of the ſhoulders; and, ſhould this prove the caſe, what can we do but wait with patience? After the delivery of the head, if the woman falls into deliquia, or if, after ſeveral pains, the ſhoulders do not follow, and the child's life be in danger from delay, we ſhould naturally be induced to help it forward in the gentleſt manner we are able, by paſſing a finger on each ſide as far as the axilla, and thus gradually pulling along.

III. Laſtly, From the ſecundines, difficulty and danger ſometimes ariſe.

1ſt, The rigidity of the membranes, and the contrary. From the firſt of theſe cauſes, the birth is ſometimes rendered tedious; but as the ſame effect is much oftener produced by the oppoſite cauſe, and the conſequences of the latter are more troubleſome and dangerous than the former, we ſhould always be exceedingly cautious of having recourſe to the common expedient of breaking the membranes, which ought never to be done, till we be certain the difficulty depends upon this cauſe; and, even then, the head of the child ſhould be well advanced, and the membranes protruded almoſt as far as the os externum. Many inconveniencies ariſe from a premature evacuation of the waters; for thus the parts become dry and rigid, a conſtriction of the os uteri for a time enſues, the pains often either remit or become leſs ſtrong and forcing, though not leſs painful and fatiguing; the dilatation goes on ſo ſlow, and the labour becomes ſo ſevere, that the woman's ſtrength and ſpirits, by the unprofitable labour, are quite overcome and exhauſted; ſo that the head remains confined in the paſſage, merely from want of force of pain to puſh it forwards. The woman in the beginning of labour ſhould therefore be treated with the utmoſt delicacy and gentleneſs. The work of nature is too often ſpoiled by officious hands. She ſhould be ſeldom touched while the membranes are whole, leſt they ſhould be ruptured; and, even when touching is neceſſary, this ſhould only be done when the pains begin to remit, and the tenſe membranous bag to relax.

2dly, Too great a quantity of water may prevent the uterus from contracting, and thus weaken the force of the pains. Though this may, however, occaſion a delay, it will never be attended with more dangerous conſequences; and the ſame advice already given will hold equally good in this caſe, that the membranes ſhould never be broken till the ſoft parts be completely dilated; and we are aſſured that the difficulty or delay proceeds only from this cauſe.

3dly, The funis umbilicalis too long. The funis may be faulty from its too great length, or the contrary: thus the extraordinary length, by forming circumvolutions round the child's neck or body, ſometimes proves the cauſe of protracting the labour. But as this can only happen when the chord is of an uncommon length, there is generally enough left to admit of the exit of the child with ſafety; and it is time enough, in general, after the child is born, to ſlip the nooſe over the ſhoulders or head: there is ſeldom occaſion to divide the chord in the birth, a practice that may be attended with trouble and hazard.

The practice of introducing a finger in ano, to preſs back the coccyx, or to prevent the head, when it advances, from being retracted by circumvolutions of the chord, is now entirely laid aſide; an expedient that can anſwer no end, but that of fretting and bruiſing the parts of the mother, and injuring thoſe of the child.

Funis too ſhort. The funis is ſometimes thick and knotty, or preternaturally thickened by diſeaſe. In this caſe, part of the placenta may be ſeparated as the child advances through the pelvis, and thus a flooding will enſue; or the funis may be actually ruptured and occaſion the death of the child, if the birth does not quickly follow. Such caſes, however, rarely happen.

An inconvenience, at leaſt fully as bad as the former, may ariſe from the too great length of the funis, though it may depend on other circumſtances: *viz.*

4thly, The prolapſus of the funis before the head. In this caſe, the funis, if poſſible, ſhould be puſhed up above the preſenting part; for, if the labour pains are ſlow, and the chord becomes cold, or the pulſation in it begins to grow languid, the circulation will thus be interrupted, and the life of the child deſtroyed. If the head is far advanced in the pelvis, and the child's life in danger, the delivery may be performed with the forceps. But to puſh up the head, and turn the child with a view to preſerve its life, as many authors recommend, is a practice by no means adviſeable: we ſhould ſeldom, in this poſition, be enabled to ſave the child; and turning under ſuch circumſtances can never be done, but at the immediate hazard of loſing the mother.

5thly, Placenta attached towards the cervix or os uteri. This caſe is truly melancholy; for, if the delivery is not ſpeedily accompliſhed, the effuſion from the uterine veſſels will be ſo copious and profuſe, that the unfortunate woman muſt, in a very ſhort time, periſh. On this occaſion the delivery muſt be conducted in the beſt manner the judgment and ſkill of the operator can direct, and with as much expedition as the ſafety of the mother will admit.

Thus, in moſt laborious caſes, provided the woman's ſtrength be ſupported, the management properly regulated, the natural moiſture of the parts when deficient ſupplied, manual aſſiſtance very ſeldom becomes

comes requifite: but as cafes do occur, wherein nature, with all advantages, will fail, and the common methods of relief prove unfuccefsful, recourfe muft be had to more powerful means, while the woman is able to fuport the conflict. In all fuch cafes, the condition of the patient, the ftructure and ftate of the parts, and pofition of the prefenting part of the child, muft very carefully be confidered.

Method of Delivery by Inftruments.

When the powers of nature are infufficient to expel the child, extraordinary affiftance muft be had recourfe to. In laborious births, this is chiefly of two kinds.

I. The head is either extracted as it prefents: or,

II. Its diameter is diminifhed previous to the extraction.

The head may be detained from advancing thro' the pelvis by all the caufes formerly enumerated. Thefe are chiefly included in four general ones,

1. Weaknefs in the mother.
2. Narrownefs of the pelvis.
3. The bulk of the head of the child: or,
4. Its difadvantageous pofition.

Whatever is the caufe, when the natural pains begin to remit, and the parts of the woman begin to fwell; when her ftrength declines, her pulfe grows feeble, and there is no profpect of advantage to be gained by delay; meafures muft be taken for affifting the delivery, otherwife both mother and child may perifh from neglect.

As inftruments are never to be employed but in the moft urgent and neceffitous cafes, and exprefsly with a view to preferve the life of mother or child, or both; thofe of a fafe and harmlefs kind fhould always be made trial of, in preference to thofe of a deftructive nature.

Ufe of the Forceps.

The forceps, is an inftrument intended to lay hold of the head of the child in laborious births, and to extract it as it prefents. This inftrument, as now improved, in the hands of a prudent and cautious operator, may be employed without doing the leaft injury either to mother or child.

In every obftetrical cafe, wherein manual affiftance becomes neceffary, the contents of rectum and bladder fhould, if poffible, be previoufly emptied.

The membranes alfo fhould be broken, the foft parts completely dilated, and the head of the child as far as poffible advanced, previous to the ufe of any inftrument.

The form and ftructure of the parts of the woman, the fituation and progrefs of the prefenting part of the child, muft at this time be carefully confidered. The concavity of the facrum, for inftance, will determine the progrefs of the labour. The touch of the vertex, fontanella, lambdoidal, or fagittal future, the fore or back part of the ear, or fome part of the face, will afcertain the true prefentation of the child.

The lower the head is advanced in the pelvis, our fuccefs with the forceps is the more to be depended on. For when it has proceeded as far as the inferior aperture, by means of this inftrument, it may be readily relieved: but when the head of the child is confined at the brim, both the application of inftruments, and the extraction by this means, are exceedingly difficult and dangerous.

The head may be fo firmly wedged in the pelvis, that the forceps can neither be introduced nor fixed without bruifing or tearing the parts of the woman: wherever, therefore, infurmountable difficulties occur, either in applying or extracting with the forceps, the life of the mother muft not be endangered by fruitlefs efforts; the head of the child muft immediately be opened, and the delivery accomplifhed without further delay.

In laborious births, the proper forceps cafes may be reduced to two, which include, however, a confiderable variety. Thefe are,

I. The fmooth part of the cranium,

II. The face, prefenting.

The head may prefent,

1ft, Naturally, when low advanced in the pelvis, with the vertex to the pubes, and the forehead or face in the hollow of the facrum. Or,

2dly, When higher in the pelvis, the vertex may prefent with the face laterally, the ears to the pubes and facrum. Or,

3dly, The fontanel may prefent with the face to the pubes, and vertex to the facrum; or with the vertex to the pubes, and face to the facrum.

1. When the head prefents naturally. The woman in this cafe muft be placed on her back a-crofs the bed, properly fupported; the accoucheur, feated before or in a kneeling pofture, after gradually lubricating the perinæum and vagina, muft proceed gently to ftretch the parts, by paffing the hand in a conical manner through the os externum vaginæ, pufhing it forwards by the fide of the child's head, till it advances as far as an ear, if poffible; along this hand he is to guide a blade of the forceps, which with the other hand he introduces in the direction of the line of the pelvis, holding the handle backwards towards the perinæum, and keeping the clam clofely applied to the child's head. This muft be infinuated very gradually by a kind of wriggling motion, pufhing it on till the blade is applied along the fide of the head over the ear: he muft then gently withdraw the firft hand from the pelvis, with which he muft fecure the handle of the blade of the forceps already introduced, till the other blade be paffed along the other hand, in the fame flow cautious manner: the handles muft then be brought oppofite to each other, carefully locked, and, left they flip in extracting, properly fecured by tying a fillet or garter round them; but this muft be loofed during the remiffion of pulling, to prevent the brain from being injured by the preffure. The extraction muft be made by very flow and gentle degrees, and with one hand only, while the other is employed to guard the perinæum: the motion in pulling, fhould be from blade to blade; the accoucheur muft reft from time to time, and, if the pains are not gone, fhould always in his efforts only co-operate with thofe of nature. The child and mother will fuffer lefs by going on in this gradual manner than by precipitating the birth, which can never be done but at the rifk of deftroying both. If, in making the extraction, the forceps flip, they muft be cautioufly withdrawn blade by blade, and again introduced in the fame manner.

manner. When the tumour of the perinæum forms, and the vertex begins to protrude at the os externum, the accoucheur muft rife from his feat, raife the handle gently upwards, and, by a half-round turn, bring the hind-head from under the fymphyfis or arch of the pubes; remembering carefully to guard the perinæum from laceration and its confequences, to which it is now fo greatly expofed.

In attempting the introduction of either blade, if it meets with any interruption, it muft be as often withdrawn, and pufhed up again in a proper direction, till every difficulty be furmounted; and if, from the fmallnefs or conftriction of the parts, the introduction of the fecond blade fhall feem impracticable, the former one muft be withdrawn, and the latter muft be firft introduced.

2. The vertex may prefent with the face laterally in the pelvis. It is always difficult to apply the forceps till the bulky part of the head has paffed the brim; and here it is not only difficult to the operator, but extremely hazardous to the patient, to introduce this inftrument till the ear of the child has got under the pubes. When the ears thus prefent to pubes and facrum, the woman fhould be placed on her fide or knees; the moft difficult blade of the forceps fhould be firft applied, which is the one under the pubes; when both are paffed, and properly fecured, the patient fhould again be turned to her back, before the operator attempts to extract, and the head in this cafe (as the quarter-turn can feldom be made with fafety) fhould be delivered in the manner wherein it prefents; becaufe, when confined any time in the paffage, its figure is altered by the overlapping of the bones, in fuch a manner that it paffes along, in general, with far lefs difficulty than to attempt to pufh up and make the mechanical turns; a work often altogether impracticable, by which contufion or laceration of the parts of the woman, and the moft fatal confequences, may be occafioned. The handles of the forceps muft here particularly be well preffed backwards towards the perinæum, that the clams may humour the curvature and intrufion of the facrum, and accommodate themfelves to the form of the child's head.

This is a cafe wherein the forceps often fail; if fo, they will fometimes fucceed by varying the mode of application, and fixing them over the forehead and occiput; if this method fails alfo, the fize of the head muft be diminifhed, and the extraction made with the blunt hook or crotchet.

3. The fontanella may prefent with the face to the pubes. This is the moft common of the fontanel cafes; though fometimes the face is lateral in the pelvis, fometimes diagonal, and fometimes it is turned to the facrum. The true pofition is afcertained by the direction of the fontanel, and that of the ear. Here, as in other laborious births, nature fhould be intrufted as long as we dare. The head does not always defcend mechanically through the capacity of the pelvis, as fome practitioners have fuppofed; nor will the deviation from its ordinary mode of defcent always of itfelf influence the delivery, at leaft very rarely in fuch a manner as to require extraordinary affiftance. In whatever manner the head prefents, when it is fituated high in the pelvis, the delivery cannot be effected without difficulty and hazard: in fuch circumftances, the application of the forceps will frequently baffle the utmoft efforts of the accoucheur, and the confequences of fuch attempts may prove fatal to mother and child.

When extreme weaknefs in the mother, floodings, convulfions, or other urgent fymptoms, render it neceffary to force the delivery, whether the face be to pubes or facrum, the forceps may be applied along the ears, in the fame manner as directed in a natural labour; and the head, for the reafons already given, fhould be brought along in the manner it prefents; the extraction fhould be made with great deliberation, that the parts of the woman may have time to ftretch; the perinæum muft be carefully fupported; the forceps muft be gently releafed, when the head is delivered; and the reft of the delivery conducted as in a natural labour.

In this cafe, when fituated high in the pelvis, the fontanel prefenting, and the face either to pubes or facrum, the long axis of the head interfects the fhort diameter of the pelvis, and very often, though the forceps be applied, and a firm hold of the head be obtained, it is not poffible to bring it along with all the force we dare exert. If this method therefore fails, the common forceps fhould be cautioufly withdrawn, and the long ones applied, if poffible, over the fore-head and occiput, when, the fize of the head, by the compreffion it fuffers in paffing along, being perhaps fomewhat diminifhed, the extraction will be fuccefsfully performed. This method alfo failing, previous to the operation of embryotomy, Dr Leak's forceps, with the third blade, may be had recourfe to. But of this little can be faid with confidence, till the inftrument has been more generally employed. From the difficulty of fucceeding in the application of the common forceps, it may, *à priori*, be concluded, that the introduction of a third blade, even in the hands of an expert practitioner, however ingenious the invention, is an expedient not eafily to be put in practice. Neither is Roonhuyfe's lever, or a blade of the forceps paffed up between the pubes and fore-head or hind-head of the child, in order to procure the delivery of the head, to be recommended in fuch cafes: however fome have boafted of its fuccefs, it is an inftrument that may do much mifchief; and few practitioners can ufe it with fafety.

II. *Face prefenting.*—Of laborious births, face-cafes, as we have already obferved, are the moft difficult and the moft dangerous. From its length, roughnefs, and inequality, the face muft occafion greater pain; and from the folidity of the bones, it muft yield to the propelling force with much more difficulty, than the fmooth moveable body of the cranium. Face-cafes are the moft troublefome that occur in the practice of midwifery, and in which the moft expert practitioners may be foiled in their attempts; and thefe attempts, if too early exerted, will be followed in many inftances with fatal confequences. Whatever way the face prefents, it fhould be allowed to advance as low as poffible in the pelvis; by which means, the accefs will be more eafy, and the pofition, for the application of inftruments, more favourable. In this aukward fituation, much mifchief may be done by rafhnefs; whereas, if time be allowed, and the

the patient be properly ſupported, the delivery will generally end well.

The face may preſent with,

1. The chin to the pubes.
2. to the ſacrum.
3. laterally.

From the difficulty of applying inſtruments in theſe caſes, ſome authors recommend, as an univerſal practice, to turn the child, and deliver by the feet. But this in general is a dangerous practice, and ſeldom or never adviſeable, except when the membranes remain entire, till the os uteri is completely dilated, and the head continues looſe above the brim of the pelvis: and even then the propriety of the practice is doubtful; becauſe, if the head is ſmall, or the pelvis be well proportioned, the face will deſcend without much difficulty; and if otherwiſe, beſides the riſk in attempting to turn, the child may be loſt from the preſſure of the chord, or the difficulty of extracting the head after the delivery of the body.

When aſſiſtance becomes neceſſary, the beſt practice in face-caſes is the following: Having placed the patient in a convenient poſture, let the accoucheur in the gentleſt manner paſs his hand within the pelvis; and, during the remiſſion of pain only, endeavour to raiſe the head of the child, ſo that he may puſh up the ſhoulders entirely above the brim of the pelvis, and thus change the poſition of the face: by this means, if ſucceſsful, he will be able to reduce the firſt of theſe caſes, ſo as to make the fontanel preſent with the face to the pubes; he will reduce the ſecond ſo as to bring down the vertex, with the face to the ſacrum; and the third, he will reduce to a vertex caſe, with the face lateral. The delivery may be afterwards truſted to nature; which failing, there is eaſier acceſs for the application of inſtruments to make the extraction, as already directed. The ſucceſs, however, of the accoucheur, in altering the poſition of the head, by puſhing it up, will entirely depend on the time he is called; for, ſhould the head be firmly wedged in the pelvis, no force he dares employ will be ſufficient to alter the poſture.

If therefore every attempt to reduce the face, and make the vertex or fontanel preſent, ſhall prove unſucceſsful, and ſymptoms are urgent, the forceps muſt be applied over the ears of the child, and the extraction performed in the beſt manner the operator is able. And, failing theſe, immediate recourſe muſt be had to the crotchet.

1. In the firſt caſe, previous to the introduction of the forceps, the chin, if poſſible, ſhould be advanced below the pubes.

2. In the ſecond, the chin ſhould be advanced to the inferior part of the ſacrum. And,

3. In the third, the chin ſhould be as low as the under-part of the tuber iſchii: and although in general the head is to be extracted as it preſents, if the operator meets with conſiderable reſiſtance, it muſt be gently puſhed up and turned with the chin, either laterally, below the pubes, or into the hollow of the ſacrum, according to the particular circumſtances of the caſe, and in a direction beſt accommodated to the form and diameter of the pelvis.

Uſe of the Sciſſars, Crotchet, and Blunt Hook.

When the head of the child, from its ſize, unfavourable poſition, or from a fault in the pelvis, cannot be protruded by the force of natural pains, nor extracted by the forceps, recourſe muſt be had to more violent means, and the life of the child muſt be deſtroyed in order to preſerve that of the mother. This operation was by the ancients called *embryotomy*.

When the head, from its extraordinary bulk, is detained at the brim of the pelvis; on evacuating the contents, the bones of the cranium immediately collapſe, and the head is afterwards propelled by the force of the labour-pains; failing which only, the extraction muſt be made with the blunt-hook or crotchet.

The unfavourable poſition of the head is of itſelf a cauſe inſufficient to juſtify the uſe of deſtructive inſtruments, which ought never to be employed but in extreme caſes, after every milder method has failed. From the difficult acceſs to the cranium in order to make a perforation and evacuate the brain, a face-caſe makes a very troubleſome and dangerous crotchet one. Very luckily, in narrow pelviſes, the face rarely preſents, and very ſeldom advances far in that direction; at other times, the poſition may be ſo altered, that the crown, the back of the ear, or ſome other part of the cranium, can be reached; otherwiſe the crotchet muſt be fixed in the mouth, orbit of the eye, &c. and the head brought along in that direction, till the ſciſſars can be employed to open the ſkull.

But the grand cauſe of difficult labour is, the narrowneſs or diſtortion of the pelvis. For when, at the brim, inſtead of four inches and a quarter from pubes to ſacrum, it meaſures no more than one and a half, one and three-fourths, two, or two inches and one-fourth, the uſe of inſtruments becomes abſolutely requiſite, and very frequently in thoſe of two inches and one-half, and three inches; or when the diameters through the capacity, or at the inferior aperture, are retrenched in the ſame proportion, difficulties will in like manner ariſe, and the delivery, except the labour be premature, or the child of a ſmall ſize, cannot be accompliſhed without the aſſiſtance of deſtructive inſtruments.

We judge of the form and ſize of the pelvis by the external make and form of the woman; by the progreſs of the labour; by the touch. When the fault is at the inferior aperture, the touch is pretty deciſive; *e. g.* if a bump is felt in the os ſacrum inſtead of a concavity; if the coccyx is angulated; if the ſymphyſis pubis projects inwards in form of an acute angle; if the tuberoſities of the iſchia approach too near each other; or the one tuber be higher than the other; ſuch appearances are infallible marks of a diſtorted pelvis. But when the narrowneſs is confined to the brim, this is only to be diſcovered by the introduction of the hand within the pelvis: the projection of the lumbar vertebræ over the ſacrum, is a ſpecies of narrow pelvis, that moſt frequently occurs in practice. In this caſe, the child's head, by the preſſure it ſuſtains between pubes and ſacrum, is moulded into a conical or ſugar-loaf form, the parietal bones are ſqueezed together, over-lapping one another, and will be felt to the touch when the labour is advanced, like an acute ridge, ſomething in the form of a ſow's back.

In-

Inftead of the complicated inftrumental apparatus invented by the ancients, fuch as fcrews, hooks, &c. for fixing in, laying hold of, and extracting the head, as it prefented, an operation in many cafes difficult and dangerous, when the head was bulky or the pelvis narrow, as the woman frequently loft her life in the attempt; the practice of diminifhing the fize of the head, by opening the cranium and evacuating the brain, previous to the extraction, is a modern improvement, and an important one: the inftruments for this purpofe confift fimply of a pair of long fciffars, a fharp curved crotchet, and a blunt hook: thefe are preferable to every other, whether of ancient or modern conftruction.

When the accoucheur is under the difagreeable neceffity of deftroying the child to preferve the mother, fhe muft be laid in the fame pofition as already advifed for the application of the forceps; and the fame rules, recommended for the one operation, will in general apply to the other.

Thus, in the narroweft pelvis that occurs, previous to opening the cranium, the foft parts fhould be completely dilated, and the head of the child fhould be fixed fteadily in the pelvis and advanced as far as poffible; for while the head is high and loofe above the brim, the application of inftruments is very difficult as well as hazardous.

The long fciffars muft be cautioufly introduced into the vagina, directed by the hand of the accoucheur; the points muft be carefully guarded, till they prefs againft the cranium of the child, which they muft be made to perforate with a boring kind of motion, till they are pufhed on as far as the refts; they muft then be opened fully, carefully re-fhut, half turned, and again widely opened, fo as to make a crucial hole in the fkull. They muft afterwards be pufhed beyond the refts, opened diagonally again and again, in fuch a manner as to tear and break to pieces the bones of the cranium; they muft then be fhut with great care, and withdrawn along the hand, in the fame cautious manner as they were introduced, left they fhould bruife or tear the uterus, vagina, or any other part of the woman. After a free opening in the cranium has thus been made, the brain muft be fcooped out with the fingers or blunt-hook, and the loofe fharp pieces of bone muft be carefully feparated and removed, that no part of the woman be tore while the head is extracting. The teguments of the fcalp fhould now be brought over the ragged bones of the cranium, and the woman fhould be allowed to reft an hour or two, according to her ftrength and other circumftances: the bones of the cranium will now collapfe; and if the woman has as much ftrength remaining, or the pelvis be not much diftorted, the head being thus diminifhed, will be protruded by the force of natural pains; otherwife it muft be extracted, either by means of two fingers introduced within the cavity of the cranium, by the blunt-hook introduced in the fame manner, guarding the point on the oppofite fide while making the extraction; or, failing thefe, by the crotchet, which, though dangerous in the hands of an ignorant rafh operator, may be employed by the prudent practitioner with as much fafety as the blunteft inftrument.

The method of introduction is the fame with a blade of the forceps. The chief thing to be attended to is, to guard the point till it be applied againft the head, and firmly fixed in its hold, which fhould always be fomewhere on the outfide of the cranium; provided a firm hold is obtained, no matter where, behind the ears, about the os petrofum, orbits of the eyes, maxilla inferior, &c. according to the prefentation of the head. The woman being properly fecured, and the handle of the inftrument covered with a cloth, the operator muft then pull, at firft gently, afterwards more forcibly, refting from time to time, and endeavouring to make the extraction in the beft manner the circumftances of the cafe will admit of. If the pelvis be much diftorted, fo that, by means of the utmoft ftrength the accoucheur can exert, little purchafe is made, he may apply to the oppofite fide a blade of the forceps, which are now fo conftructed as to lock with the crotchet; let him then bring the handles together, fecure properly, and thus endeavour to make the extraction. Should this expedient alfo fail, the blade of the forceps muft be withdrawn, the other blade of the crotchet muft be applied, the handles brought together and fecured, and the extraction made, moving from blade to blade.

Should the head prefent in fuch a manner, that, in attempting to extract it, the crotchet divides the vertebræ of the neck, and the head is thus fevered from the body, an accident that can only happen in the hands of an ignorant blundering practitioner; the head muft be pufhed up above the brim of the pelvis, the crotchet or blunt hook muft be fixed under the axilla, the arms muft be brought down, and the body extracted, by fixing the crotchet below the fcapula on the fternum, or among the ribs; the head muft afterwards be extracted in the manner already advifed: or fhould the head in extracting be pulled from the body, as may happen when the child has been long dead, or when it is putrid, the delivery of the body muft be effected by means of the crotchet as now directed; a method preferable to that of turning, as fome advife.

If the head, inftead of yielding to the force of pulling, be at laft cut and broken in pieces, the operator muft endeavour to bring down an arm of the child, to fix the crotchet about the jaw or neck, pull at both holds, and thus attempt to make the extraction; this alfo failing, he muft bring down the other arm, fix the crotchet in the thorax, and, in a word, muft tear the child in pieces, that the delivery may be accomplifhed by any means.

In face-cafes, where it is impracticable to alter the pofition, and when the pelvis is much diftorted, the double crotchet is fometimes requifite; the handles muft be well fecured, kept well backwards towards the perinæum, and the motion always from blade to blade. It very feldom, however, happens, that there is occafion for the double crotchet: by this means the head is flattened in pulling; whereas if one blade only can be employed, the head is lengthened, and, in pulling, can better accommodate itfelf to the fhape of the pelvis as it paffes along.

Chap. XII. *Preternatural Labour.*

In whatever manner the child prefents when the body is delivered before the head, the birth is accounted preternatural.

Preternatural labours may be referred to one of the four following claffes.

I. When

I. When one or both feet, knees, or the breech, present.

II. When the child lies acrofs in a rounded or oval form, with the arm, fhoulder, fide, back, or belly, prefenting.

III. When one or both of the upper extremities prefent, the child lying in the form of a fheath, the feet towards the fundus uteri, the waters evacuated, and the uterus ftrongly contracted round the body of the child.

IV. Laftly, Premature or flooding cafes, or others in which it may be neceffary to force the delivery, either previous to the rupture of the membranes, or quickly after it.

The caufes of crofs labours moft commonly affigned by authors, are, The obliquity of the uterus, circumvolutions of the funis umbilicalis round the child's body; the fhortnefs of the funis, or attachment of the placenta towards the fundus uteri; fhocks affecting the mother when pregnant, &c. The pofition of the fœtus may alfo be influenced by its own motion and ftirrings, by the particular form and bulk of its body, by the manner of ftretching of the uterus, by the quantity of liquor amnii, and by many other circumftances.

The fymptoms that indicate an unfavourable pofition of the child, before it can be difcovered by the touch, are very uncertain and fallacious: a crofs birth may, however, be fufpected,

1ft, If the pains be more flack and trifling than ordinary.

2dly, If the membranes be protruded in a long form like a gut, or the finger of a glove.

3dly, If no part of the child can be difcovered when the uterine orifice is confiderably opened.

4thly, If the prefenting part through the membranes be fmaller, feels lighter, and gives lefs refiftance than the bulky ponderous head.

5thly, Laftly, after the rupture of the membranes, if the meconium of the child be paffed along with the waters, it is a fign that the breech prefents, or that the child is dead.

Preternatural labours are difficult or hazardous, according to,

1. The form of the pelvis, and general health and conftitution of the woman.

2. The bulk of the child, and its manner of prefenting.

3. The time the waters have been evacuated, and the uterus contracted round the body of the child.

4. When complicated with plurality of children; the prolapfus of the funis umbilicalis; the limbs of the child intangled with the chord; profufe and violent floodings from the attachment of the placenta towards the cervix uteri, &c.

Turning is often laborious, and always dangerous in proportion to the force ufed in fearching for and bringing down the feet; though, in general, the difficulty and hazard are not fo great, as in many cafes ftrictly called *laborious*, when the head prefents; the treatment of preternatural labours being better known, and for the moft part eafier put in practice.

Each clafs of the general divifion of crofs labours includes a variety of different cafes. By confidering a few of every clafs, a general idea of the whole will be formed.

CLASS I.

Case 1. The fimpleft and eafieft cafe is the Agrippan pofture, when the child prefents with the feet.

The foot is to be diftinguifhed from the hand, firft, by the weight and refiftance it gives to the touch; fecondly, by the fhortnefs of the toes; thirdly, by the projecting heel.

When the feet prefent in the paffage, the labour fhould be allowed to go on as if natural. If the child be of an ordinary fize, the woman in health, the parts well proportioned, in the way of affiftance nothing further feems neceffary but the application of a warm cloth round the body of the child, which muft be properly fupported till it advances as far as the pains are able to force it. If the fize be ordinary, or rather fmall, it will fometimes make the mechanical turns, and be entirely pufhed along by the force of the natural pains; but it generally ftops at the fhoulders, after the breech protrudes without the os externum, where the refiftance is fo great, that the accoucheur's affiftance becomes requifite.

In this cafe, the patient muft be placed on her back, properly fupported; the hand of the accoucheur muft be cautioufly introduced; the parts of the woman muft be gently ftretched; the feet of the child muft be laid hold of, and brought as low in the vagina as poffible; a foft warm cloth muft be wrapped round them, and the extraction muft be performed in a flow, cautious manner, making large motions in a circular or lateral direction, refting from time to time, if the pains are gone; and if not, always waiting for the natural efforts. When advanced as far as the breech, the body, if not already in a proper direction, muft be pufhed up, and gently turned with the face towards the mother's back; and to make fure that the face turns with the body, or to prevent the chin, vertex, or fhoulders from catching on the pubes, or angle of the facrum, an extraordinary quarter-turn more muft be made: this muft be reverfed previous to the extraction; and the difficulty arifing from the obftruction of the fhoulders muft be removed in the following manner. While the breaft and legs of the child are fupported over the palm and forearm of the one hand of the accoucheur, which he draws towards one fide, he muft introduce two fingers of the other hand at the oppofite fide into the vagina, over the back-part of the fhoulder, as far as the elbow, ande ndeavour in the moft gentle manner to bring down the arm, always remembering, in his movements, to humour the natural motions of the joint: he muft then fhift hands, when the other arm is to be relieved in the fame manner: both arms being brought down, the woman muft now reft a little, when a pain or two generally follows, and the head is alfo forced along. But fhould the woman be much exhaufted, and if the head does not quickly advance, the child may be loft from delay. The extraction of the head in preternatural labours, is often the moft difficult and the moft dangerous part of the delivery; the caufe of refiftance, when it does not advance, is chiefly owing to its confinement between the angle of the facrum and pubes, when the bulky part of the head is detained at the brim; whether the refiftance be here or towards the inferior aperture of the pelvis, if the head does not advance in a pain or two, the extraction muft be made in this manner:

Preternatural Labour.

ner: While the right hand of the accoucheur supports the body of the child below, with two fingers preffing on either fhoulder, the left hand and fingers muft in the fame manner be placed over the back of the neck, and pulling gently in the direction from pubes to facrum, he muft thus endeavour to bring it along: but, fhould the pelvis be narrow, or the child's head of a large fize, or the face be laterally or anteriorly placed in the pelvis, or, what rarely happens, the os uteri contracted round the neck of the child; in either of thefe cafes, the accoucheur will fometimes meet with the utmoft difficulty. When the above method therefore fails, he muft introduce two fingers of the right-hand into the child's mouth, while thofe of the left-hand are expanded over the fhoulders, as already directed; and in this way he muft endeavour to relieve it, pulling from pubes to facrum, alternately raifing and depreffing the head till it advances low down, fo that the face defcends from the hollow of the facrum, when the accoucheur muft rife from his feat, and bring the hind-head from under the pubes with a half-round turn, imitating that of a natural labour.

If the pofition be unfavourable, the face, if poffible, fhould be turned to the facrum, by pufhing up the head, or by pufhing back the chin: If the contraction of the uterus is the caufe of refiftance, which rarely occurs, it muft be gently ftretched with the fingers. Or if the difficulty arifes from circumvolutions of the chord round the legs, thighs, body, or neck of the child, thefe muft be difengaged in the eafieft manner poffible; it is rarely neceffary to divide the funis on this account.

Should every method fail in bringing down the head, the delivery muft be effected by means of the forceps cautioufly paffed over the ears, with the handles under the child's body, in a direction downwards towards the perinæum. If the pelvis be very narrow, or the head of a large fize, it muft be opened by pufhing the fciffars through the occipital bone, fo that the contents of the cranium may be evacuated, and the extraction made by means of the forceps, blunt-hook, or crotchet. But if the head, by the efforts to extract it, be actually fevered from the body, and left behind in the uterus, an accident which fometimes occurs, it muft be delivered by inclofing it in the forceps, while fecured from rolling by preffing externally on the abdomen. If the forceps cannot be applied, the cranium muft be opened, the texture of the brain deftroyed, and the extraction performed by the fingers of the accoucheur, by the blunt-hook, or by the crotchet. If the under-jaw remains, the head may be effectually fecured till locked in the forceps, or till its bulk be diminifhed, by introducing a finger into the mouth, thrufting it through the jaw under the chin, drawing it down, and paffing a ligature through the perforation.

In cafes where the child has been long dead, fhould the belly or thorax be diftended with air or water, and prove the caufe of obftruction, the contents muft be evacuated by opening with the fciffars, or tearing with the crotchet; and in general, where difficulties occur, the delivery muft be accomplifhed in that manner the circumftances of the cafe will beft admit of.

Cafe 2. When inftead of two, one foot only falls into the vagina, the other is fometimes detained by catching on the pubes, and, if eafily come at, fhould be brought down, always remembering to humour the natural motion of the joint; but, fhould the leg be folded up along the child's body, the attempt is fometimes both difficult and dangerous, and ought not to be perfifted in, as the breech will either be forced down by the affiftance of natural pains, or by gently pulling by one leg only.

Preternatural Labour.

Cafe 3. When one or both knees prefent, the delivery muft be conducted in the fame manner with that of the feet.

Cafe 4. When the feet offer along with the breech, this laft muft be pufhed up, while the former are fecured and brought down, till it be reduced to a footling cafe, and otherwife managed as above.

Cafe 5. The breech may prefent with the fore-parts to the mother,

1ft, Anteriorly.

2dly, Laterally. Or,

3dly, Pofteriorly.

Sometimes the breech may be difcovered, previous to the rupture of the membranes; but afterwards with more certainty, by the meconium of the child paffed with the waters, and by the touch.

In whatever manner the breech prefents, the delivery fhould be fubmitted to nature, till the child be advanced as far as the thorax, when the feet are to be brought down and laid hold of, the child, if neceffary, pufhed up, the mechanical turns effected, and the delivery otherwife conducted as in a footling cafe. There is much lefs hazard in general, agreeable to an old obfervation of Mauriceau, in allowing the child to advance double, than in precipitating the extraction by pufhing up to bring down the feet before the parts have been fufficiently dilated; a practice difficult and troublefome to the operator; painful, and fometimes dangerous, to the mother; and by which the child is expofed to the rifk of ftrangulation, from the retention of the head after the delivery of the body. If the child be fmall, though doubled, it will eafily pafs in that direction; if large, though the labour be painful, the natural throes are lefs violent and lefs dangerous than the prepofterous help of the accoucheur: If the child thus advances naturally, it will be lefs expofed to fuffer; if it does not advance, the parts of the mother will be prepared for the accoucheur to pafs his hand into the pelvis, to raife up the breech, to bring down one or both feet, and deliver as above.

Weaknefs in the mother, floodings and convulfions, a very large child, or narrow pelvis, the prolapfus of the funis, or its compreffion between the thighs of the child, or between the child and pelvis, by which its life is endangered, if the chord cannot be reduced above the prefenting part, are the only exceptions to the general rule of treating the breech as a natural labour.

The practice of helping forward the breech, by paffing the blunt-hook under the ham, is now entirely laid afide: this can never be done with fafety, till the breech be fo low advanced, that the hand of the accoucheur can be ufed, which may be employed with more advantage as well as fafety.

Preternatural Labour.

CLASS II.

In the former claſs of preternatural labours, it is adviſeable to truſt to nature in many caſes, as the birth will often be accompliſhed without manual aſ-ſiſtance: but when the child lies a-croſs, no force of pain can make it advance in that poſition; and, without proper aſſiſtance, both the mother and child would periſh.

If the accoucheur has the management of the labour from the beginning, the child may be turned, in the worſt poſition, without difficulty; but when the waters have been for ſome time evacuated, and the uterus ſtrongly contracted, turning is laborious to the operator, painful and dangerous to the mother. In ſuch caſes, the ancients endeavoured to make the head preſent; but, from its bulk, they often failed, and the attempt was often attended with fatal conſequences. The method of delivering by the feet is the moſt important modern improvement in the practice of midwifery; an improvement to which many thouſands owe their lives.

When the child lies in a tranſverſe poſition, the accoucheur muſt inſinuate his hand through the vagina into the uterus in the gentleſt manner, ſearch for the feet, bring them down with the utmoſt caution, and finiſh the delivery as in footling-caſes. To effect this, the following rules ſhould be obſerved.

1. The patient muſt be placed in a convenient poſture, that the operator may be able to employ either hand, as the various circumſtances of the caſe may require.

2. Though the beſt poſture, in general, is laying the woman on her back, it will be ſometimes neceſſary to turn her to her ſide; and, in theſe caſes, where the abdomen is pendulous, where it is difficult to reach the feet, or where they lie towards the fundus uteri, the woman ſhould be placed on her knees and elbows.

3. An exact knowledge of the true poſition of the child, and of the ſtructure and ſtate of the parts, ſhould be acquired, before attempting to make the delivery.

4. The orifice of the uterus ſhould be enlarged, ſo as freely to admit the hand; and the ſtrong pains ſhould be abated, before any attempt be made to deliver.

5. Should the waters be drained off, the parts dry and rigid, and the uterus contracted round the child, warm oil muſt be injected into the uterus, otherwiſe its rupture may be endangered.

6. In paſſing the hand into the uterus, this muſt be done in the gentleſt manner; the parts muſt be well lubricated with butter or pomatum; the line of the pelvis muſt be attended to; the efforts of the operator muſt be ſlow and gradual; and thus the utmoſt rigidity in the ſoft parts will, in time, be overcome.

7. The hand muſt be introduced only during the remiſſion of pain; when pain comes, the accoucheur muſt always reſt; otherwiſe he may puſh his hand, or the fœtus, through the body of the uterus.

8. In puſhing up, to come at the feet, this muſt never be done with the points of the fingers, nor with the hand clenched, but with the palm of the hand, or the broad expanded fingers, and always during the remiſſion of pain, and the latter ſhould alſo be obſerved in bringing down the legs; but, in making the extraction of the body, the efforts of the operator ſhould always co-operate with thoſe of nature.

9. The hand ſhould, if poſſible, be introduced along the anterior parts of the child; and both feet, if eaſily come at, ſhould be laid hold of.

10. In turning, the accoucheur ſhould never conſider the child as dead, nor allow himſelf to be deceived by ſymptoms doubtful and fallacious; the child is ſometimes born alive when he would leaſt of all expect it; therefore, in puſhing up, bringing down the legs, or extracting the body, it ſhould be handled with the greateſt delicacy.

11. When the hand is within the pelvis, it ſhould not always be moved in the line of the umbilicus, but rather towards one ſide of the ſpine, by which more room is gained, and the prominent angle of the ſacrum avoided.

12. The hand ſhould be paſſed as far as the middle of the child's body, before attempting to ſearch for the feet; or before attempting to break the membranes, ſhould theſe remain entire, till the aperture of the uterus will admit of the hand.

13. If the hand cannot paſs the preſenting part of the child to come at the feet, inſtead of violently puſhing back, the part ſhould be as it were lifted up in the pelvis, and moved towards a ſide; by which means difficulties may be ſurmounted, and great danger often prevented.

By attending carefully to the above rules, laceration of the uterus, floodings, convulſions, inflammations, and their conſequences, may be prevented; accidents that frequently happen in the hands of ignorant raſh operators.

Caſe 1.—*The arm preſenting.* The right is to be diſtinguiſhed from the left by laying hold of the child's hand, in the ſame manner as in ſhaking hands; and thus the general poſition of the child may be judged of.

When the accoucheur is called in early, the reduction is generally practicable: but if the arm protrudes through the vagina, and the ſhoulder be locked in the pelvis, it is needleſs, by fruitleſs efforts, for the accoucheur to fatigue himſelf, and diſtreſs his patient, to attain a point by which he will gain no very material advantage; as the hand can be paſſed into the uterus by the ſide of the child's arm, which will, of courſe, return into the uterus when the feet are brought down into the vagina.

In order to make the delivery, the hand of the accoucheur, well lubricated, muſt be conducted into the uterus by the ſide of the child's arm, along the thorax, at the oppoſite ſide of the pelvis where the head lies; if any difficulty occurs in coming at the feet, this hand muſt be withdrawn, and the other introduced in its ſtead; and if ſtill the hand cannot eaſily paſs beyond the child's head or ſhoulder, the preſenting part muſt be raiſed up, or gently puſhed to a ſide, that one or both feet may be laid hold of, which muſt be brought as low as poſſible, puſhing up the head and ſhoulders, and pulling down the feet alternately, till they advance into the vagina, or ſo low that a nooſe or fillet can be applied; and thus by pulling with

Preternatural Labour.

with the one hand by means of the noofe, and pufhing with the other, the feet can be brought down and the delivery finifhed, however difficult.

The method of forming the noofe is by paffing the two ends of a tape or garter through the middle when doubled; or fhould the garter be thick, by making an eye on one extremity, and paffing the other end through it: this, mounted on the points of the fingers and thumb of the accoucheur's hand, muft be conveyed into the uterus, paffed over one or both feet and ankles, and fecured by pulling at the other extremity.

Cafe 2.—*The fide.* This is difcovered by feeling the ribs.

Cafe 3.—*The back.* This is difcovered by feeling the fpine.

Cafe 4.—*The belly.* This is known by the funis.

Thefe cafes occur rarely, as the uterus muft with difficulty admit of fuch pofitions. When any of thefe parts do prefent, the child feldom paffes any part of the brim of the pelvis, and is, in general, more eafily turned than in feveral poftures in which it may offer. The belly, from the difficulty with which the legs can be bended backwards, except the child be flaccid, putrid, or before the time, will very feldom directly prefent; if fo, it will be early and readily difcovered by the prolapfus of the funis, and there will be no great difficulty to come at the feet, and deliver. The rule in all thefe cafes is, to pafs the hand into the womb in the gentleft manner poffible, and to fearch for the feet and bring them down.

CLASS III.

When the child lies longitudinally in the uterus, with the arm or fhoulder prefenting, and the head more or lefs over the pubes, or laterally in the pelvis, the feet towards the fundus uteri, the waters evacuated, and uterus contracted round the child's body; thefe are the moft difficult and laborious of all the cafes of preternatural labours. Here the protruding arm ought, if poffible, to be reduced, and the head brought into the pelvis; for unlefs the child be very fmall, it is impoffible for the head and arm to pafs along together.

In order to effect the reduction of the arm, different inftruments have been invented; but the hand of the accoucheur is preferable to every thing of this kind, whether of ancient or modern invention. This, conducted by the arm that protrudes, muft be infinuated through the vagina into the uterus, as far as the fhoulder of the child, which, if the accoucheur can raife up, he will generally fucceed in reducing the arm. Should this method fail, he muft attempt to pufh up the fore-arm at the elbow; but, in bending it, muft be very cautious, to avoid overftraining or diflocating the joint. In whatever manner the reduction is accomplifhed, if any method proves fuccefsful, the arm muft be retained till the head, by the force of natural pain, enters the pelvis, and prevents its return; otherwife the arm will defcend, as often as it is reduced.

But if the attempts for reduction prove impracticable, the woman muft be placed on her knees and elbows, and the accoucheur, with great deliberation, muft endeavour gently to flide up his hand between the uterus and child as far in the uterus as poffible, to lift up the head and fhoulders, and fearch for and bring down one or both feet, in the beft manner the various circumftances of the cafe will admit of. As foon as they can be laid hold of, they muft be gradually brought down into the vagina, fo low that the noofe can be applied over them, which muft be fixed and pulled with the one hand, while the head and upper parts of the body are raifed and gently pufhed up with the other.

Should the arm have been long protruded without the os externum, much fwelled, and cold; the waters drained off; the uterus ftrongly contracted; and the pofition of the child fuch as to render it impracticable, either to reduce the protruded limb, or to fearch for and bring down the feet; the head, if eafily come at, muft be opened and extracted with the blunt-hook or crotchet; or a crotchet muft be fixed amongft the ribs, and the breech or feet thus pulled down.

Should the pelvis be very narrow, and unfurmountable difficulties occur, the arm muft be twifted off at the elbow, though this expedient is rarely neceffary; and the delivery muft in general be accomplifhed as the prudence and judgment of the operator can beft direct; always remembering, when one life muft fall a facrifice, that the tree muft be preferved at the expence of the fruit.

In this, as in other cafes, the fwelling and coldnefs of the arm, and even want of pulfation in the artery, are not infallible figns of the child's death; and fhould this even be fo, it makes little difference in the mode of delivery, unlefs that it will lead us to pay all our attention to the mother: For a living child gives no more affiftance in the birth than a dead one, whatever authors have faid to the contrary.

When both arms prefent, the delivery muft be conducted in the fame manner as when one only prefents. The former cafe is lefs difficult than the latter, as the head feldom advances far when both arms fall into the paffage, fo that they can either be reduced, or there is eafy accefs to come at the feet to bring them down and deliver.

CLASS IV.

When the membranes remain entire, till the foft parts are fo much dilated, that the hand will readily find admittance; or when the hand can be paffed within the cavity of the uterus, immediately after the rupture of the membranes, fo that part of the water may be retained; the delivery may be accomplifhed, in the moft troublefome preternatural cafes, with the greateft fafety and expedition. But when the waters have been long evacuated, and the uterus clofely contracted round the body of the child, the cafe will prove laborious to the operator, painful and dangerous to the mother and child.

When there is reafon to fufpect that the child lies acrofs, which can often be afcertained, either by feeling the prefenting part through the membranes, or by fome of the figns of preternatural labours already mentioned; the woman fhould be managed in fuch a manner, that the membranes may be preferved entire as long as poffible; for this purpofe fhe fhould keep quiet in bed, and her pofture fhould be fuch as is leaft favourable for ftraining, or exerting force during the pain:

Preternatural Labour.

pain: ſhe ſhould be touched as ſeldom as poſſible, till the os internum be ſufficiently dilated. The accoucheur ſhould then introduce his hand in a conical form, well lubricated, into the vagina, and through the aperture of the internal orifice, inſinuating it between the uterus and the membranes, till it advances almoſt as high as the fundus uteri, when he muſt break the membranes, by pinching ſome part of them between a finger and thumb, or by forcibly puſhing a finger thro' them; he muſt then ſearch for, and endeavour to lay hold of, one or both feet, and deliver.

Should the membranes be ruptured in the attempt, he muſt be ready to run up his hand as quickly as can be done with ſafety, when, part of the waters by his arm being retained, the operation of turning will be facilitated. Should the placenta adhere on that ſide of the uterus where the hand is paſſed, it muſt again be withdrawn, and the other hand be introduced in the oppoſite ſide.

Floodings. It has been already obſerved, that a flooding ſeldom proves fatal to the mother before the ſeventh month of pregnancy; after which period, from its duration or exceſs, the life of both the mother and child may ſuffer. Should therefore a flooding attack a woman in the two laſt months of pregnancy, from whatever cauſe it may ariſe, and whether attended with labour-pains or not, if the hæmorrhage be ſo conſiderable that ſhe is ready to ſink under it, and that cold applications and other means of checking the evacuation ſhall fail, the woman muſt be placed in a proper poſture, her friends prudently appriſed of her danger, and the delivery muſt be immediately performed, by ſtretching the vagina and os uteri, till the hand of the operator can eaſily gain admittance to break the membranes, catch hold of the feet, and extract the child.

If it can poſſibly be prevented, the membranes in flooding caſes ſhould never be broken till the aperture of the uterine orifice will freely admit the hand to paſs, that, after the evacuation of the waters, the accoucheur may have it in his power either to make the delivery or not, according as the effuſion continues or abates.

Soon after attempting to ſtretch the parts, ſhould the labour-pains come on, the waters begin to be collected, and the uterine hæmorrhage diminiſh, the accoucheur muſt then withdraw his hand, and manage the delivery according to circumſtances. And if, for inſtance, the child preſents naturally, the delivery muſt be truſted to nature; otherwiſe, if the flooding continues, or the child preſents acroſs, the accoucheur muſt perſiſt in his work, going on ſlowly, and with the utmoſt delicacy, till he be able to reach the feet, to bring them down, and deliver; always remembering, during this proceſs, that the ſtrength of the woman, by proper nouriſhment, be ſupported.

But ſhould the placenta adhere to the cervix, or upon the os uteri, the greateſt danger is to be dreaded; for thus the flooding will commence from the moment the os uteri begins to ſtretch, and will increaſe ſo rapidly, that the woman, if not ſpeedily delivered, muſt inevitably ſink under it. The whole body of the placenta, in ſuch caſes, is ſometimes ſeparated when the labour has made but little progreſs; ſo that the woman will often periſh, whether delivery be attempted or not. As this, however, is the only expedient by which her life, and that of the child, can be ſaved; in every caſe where the placenta preſents, which the accoucheur will readily diſcover by the touch of the ſoft pappy ſubſtance of that body, he muſt immediately place the woman in a proper poſture, inſinuate his hand gently by the ſide of the protruding placenta, break the membranes, ſearch for the feet of the child, and bring them down, ſo that the delivery may be finiſhed with all poſſible expedition; for, in this unhappy caſe, a few minutes delay may prove fatal.

Preternatural Labour.

The after-birth ought never to be extracted before the child, if it can poſſibly be avoided.

After delivery, time ſhould be given for the uterus to contract, that nature may thus throw off the placenta, which never ought to be hurried away, unleſs the continuance or a recurrence of the hæmorrhage render it neceſſary.

Prolapſus of the funis. Difficulties ariſing from the funis falling down into the vagina, and preſenting along with ſome part of the child, may, in this claſs of the diviſion of preternatural labours, be included.

A preſſure on the chord, in ſuch a degree as to interrupt the circulation, muſt infallibly deſtroy the life of the child: hence a coldneſs and want of pulſation in the chord is the trueſt criterion of the death of the child; and hence, in every caſe where the chord is prolapſed before any bulky part of the child, if the delivery be not accompliſhed with expedition, the child will periſh. This is only to be prevented by replacing the chord, and retaining it above the preſenting part, till this laſt, by the force of labour-pains, be ſo far advanced as to prevent the return of the former; or the child muſt be turned and brought by the feet, provided this can be done with ſafety to the mother. But it is often difficult to ſucceed in the attempt of the one or other; and, if the woman has ſtrong pains, ſuch attempts are not to be hazarded, as the conſequences may prove fatal.

When the accoucheur is thus ſituated between two puzzling difficulties, the preference muſt always be given to the mother. If the child be ſmall, and the pelvis well formed, which may be known by the hiſtory of former deliveries, and if the labour goes on quickly, the child will generally be born alive; but if, on the contrary, the child be above the ordinary ſize, and the pelvis rather narrow, turning will prove a dangerous operation to the mother, and there is little proſpect of ſaving the infant by this means.

Beſides our former diviſion of labours, *plurality of children*, *monſters*, *extra-uterine fœtuſes*, and the *Cæſarean operation*, are parts of the ſubject that yet remain to be conſidered.

Chap. XIII. *Plurality of Children.*

The caſe of twins often occurs: of triplets ſeldom: of quadruplets rarely: nor is there perhaps a ſingle inſtance, where five or more diſtinct fœtuſes have been found contained in the human uterus, though many ſuch fabulous hiſtories have been recorded by credulous authors.

The ſigns of two or more children, ſuch as the ſudden or extraordinary increaſe of the uterine tumour, motion felt in different parts of the abdomen, &c. are very

Plurality of Children. very doubtful and fallacious: this can only be afcertained after the delivery of one child; and even then a recurrence or continuance of labour-pains is not a certain and infallible criterion; neither is the abfence of pains a fure indication of the contrary; as many cafes have occurred, where feveral days have intervened between the birth of a firft and fecond child. The chief fymptoms to be depended on are, 1ft, The child being of a fmall fize, and the quantity of liquor amnii fo inconfiderable as not to account for the bulk of the woman in time of pregnancy. 2dly, The bleeding of the funis umbilicalis next the mother. 3dly, The remora of the placenta. 4thly, The uterine tumour not fenfibly diminifhed, which, very foon after delivery, in ordinary births, will be found gradually fhifting lower and lower, and will feel at laft as if a hard circumfcribed tumour like a ball between the umbilicus and pubes. Hence the utility of the general practice of applying the hand externally on the abdomen, in every cafe after delivery; by which an accurate knowledge will be formed of the nature and manner of the uterine contraction. When, from any of thefe circumftances, there is reafon to fufpect another child, the moft certain and infallible method of difcovering it is, the paffing of a finger, or the introduction of the hand, into the uterus, where another fet of membranes will be perceived, and probably fome part of the child prefenting through them.

The pofition of twins or triplets is commonly that which is moft commodious, and which will occupy the leaft room in utero: their fituation is often diagonal; tho' they may prefent in every poffible pofture. Thus, therefore, the general rules recommended for the delivery of one child, are equally applicable in the cafe of twins, triplets, &c.

It has been the general practice with many, after the birth of one child, to pafs the hand immediately into the uterus, to break the membranes, catch hold of the feet of the child, and thus deliver. But this is certainly bad practice, whatever authors have faid to the contrary. If the woman is healthy, and the child prefents favourably, that is, with the head, breech, or feet, natural pains ought to be waited for, when the child will be expelled by the force of thefe only; failing which, manual affiftance, as in other cafes, muft be had recourfe to.

It very rarely happens, when the firft birth is preternatural, that the fecond membranes are ruptured in making the extraction. Should this prove the cafe, the limbs of the children may be confounded, fo that a leg and an arm, or three legs, or arms of different children, may prefent; which, however, will make little difference in the mode of delivery: the accoucheur will endeavour to lay hold of the foot or feet moft readily within his reach, and will be cautious in bringing them down, to make fure they belong to the fame body.

If the child prefents crofs; if floodings, convulfions, or other dangerous fymptoms, fhall take place; if the woman has fuffered much in the firft labour; and if, after feveral hours, a recurrence of labour-pains does not enfue; the hand muft then be introduced into the uterus, the membranes muft be broken, and the child muft be extracted by the feet: or, if the head remains locked in the pelvis, and, from want of ftrength in the woman, cannot be expelled, the treatment is the fame as in other laborious births.

In twin-cafes it may be recommended as a general rule, to avoid precipitating the delivery of the fecond child till the woman fhall have refted a proper time, and till, by the contraction of the fundus uteri, the fecond fet of membranes occupy the place of the firft, and be protruded as far as the os externum, when, and not before, the delivery may fafely be affifted, fhould circumftances occur to render fuch affiftance neceffary: whereas, by breaking the membranes and evacuating the waters when the child lies high in the uterus, a flooding may be brought on, or a fpafmodic conftriction of the uterus round the body of the child may be occafioned, which may render the delivery both difficult and dangerous.

The placentæ of twins, triplets, &c. generally adhere, though fometimes they are diftinct, and may be thrown off at different times after the birth of the different children; fo that the practitioner fhould be on his guard, and never fhould leave his patient till he makes fure there be no more children. When a fecond child is difcovered, no attempts ought to be made to extract the placenta till after the birth of the remaining child or children; as the woman would be fubject to flooding, which might prove of fatal confequence before the uterus could be emptied of its contents.

In cafe of plurality of children, a fecond ligature fhould be applied on the funis, on that end next the mother, immediately after the birth of every child; and a gentle compreffion fhould be made on the abdomen of the woman after the firft delivery, which muft be gradually tightened after every fucceeding one, to prevent the confequences of a fudden removal of uterine preffure, which is to be dreaded where the diftention has been confiderable.

The placenta, in fuch cafes, muft be managed in much the fame manner as ufual. In twins, &c. it generally feparates with great facility, provided time has been given for the uterus to contract. Both chords fhould be gently pulled; and when it advances towards the uterine orifice, where, being large and bulky, it commonly meets with confiderable refiftance, it requires the introduction of a finger or two into the vagina for bringing down the edge, after which the body readily follows.

CHAP. XIV. *Monfters.*

Monfters. THESE are of various fizes and forms, and, unlefs very fmall, the pofture favourable, and the woman well made, will prove the caufe of a difficult and troublefome delivery. Sometimes a child is monftrous from a preternatural conformation of parts, fuch as a monftrous head, thorax, abdomen, &c. At other times, there is a double fet of parts, as two heads, two bodies with one head, four arms, legs, &c. But fuch appearances very feldom occur in practice; and, when they do, the delivery muft be regulated entirely according to the circumftances of the cafe. A large head, thorax, or belly, muft be opened. If two bodies united together are too bulky to pafs entire, they muft be feparated; the fame of fupernumerary limbs. If the pofture be unfavourable, it muft be reduced when practicable; otherwife the extraction

muft

Cæfarean Operation.

muft be made with the crotchet, in the beft manner the circumftances of the cafe will admit of; always, in cafes of danger or difficulty, giving the preference to the fafety of the mother, without regarding that of the child.

Chap. XV. *Cæfarean Operation.*

When the delivery could not be accomplifhed by other means, or when a woman died fuddenly with a living child in her belly, an operation to preferve the life of mother and child in the former cafe, and to fave the child in the latter, has been recommended, and fuccefsfully performed, by different authors, and in different ages.

This operation is of ancient date; it is the *fectio Cæfarea* or *partus Cæfareus* of the Latins, and the *hyfterotomia* of the Greeks. Whether it was ever fuccefsfully performed on the living fubject amongft the ancients, feems uncertain; but that it has been fuccefsfully practifed by the moderns on various occafions, and in feveral different countries of Europe, there are fo many authentic hiftories on record, that the fact will fcarce admit of doubt: but as this, like many other falutary inftitutions, has been much abufed, and in many cafes improperly and injudicioufly employed, (for fome of thofe women who furvived the operation, were afterwards fafely delivered of living children), the circumftances which render this operation neceffary, demand a very particular inquiry, viz.

1. A narrownefs, or bad conformation of the bones of the pelvis.
2. Imperforated vagina, or contractions in the vagina, cicatrices, tumors, or callofities in the os uteri, &c.
3. The efcape of the child through the uterus when torn.
4. Ventral conceptions.
5. Herniæ of the uterus.
6. The pofition or bulk of the child.

It will be neceffary carefully to examine thefe different caufes, in order to fhew, that they are by no means, in every cafe, fufficiently powerful motives for having recourfe to it.

I. Bad conformation of the bones of the pelvis. When the hand of the operator cannot be introduced within the pelvis; or, in other words, when its largeft diameter does not exceed one inch, or one inch and a half, this conformation is perhaps the only one which renders the Cæfarean operation abfolutely neceffary: happily, however, fuch a ftructure very feldom occurs in practice; and when it does, the accoucheur will readily difcover it, by attending to the following circumftances, and to the common marks of a narrow pelvis. Wherever the capacity of the pelvis is fo ftrait as not to admit any part of the child's head to enter, nor two fingers of the accoucheur's hand to conduct proper inftruments to tear, break down, and extract the child piece-meal; in this cafe, recourfe muft be had to the Cæfarean fection: an expedient, though dreadful and hazardous, that will give the woman and child the only chance of life; and which, if timely and prudently conducted, notwithftanding of the many inftances wherein it has failed, may be performed with fome probability of fuccefs.

It is true, the fuccefs of the operation in the city of Edinburgh, where it has been done five times, has proved difcouraging, as none of the women had the good fortune to furvive it many days. This, however, is not the fault of the operation; but is to be imputed to the low, weak ftate of the patients at the time, who had previoufly been feveral days in labour, and their ftrength greatly exaufted, before the operator was called. Delivery by every other means was utterly impracticable; the operation, tho' the event was doubtful, alone gave a chance of life; and three of the children by this means were extracted alive.

Cæfarean Operation.

Mr Hamilton furgeon and profeffor of midwifery in Edinburgh, having been an eye-witnefs of the operation the laft time it was performed here, gives the following account of the cafe which fell under his obfervation.

Elifabeth Clerk, aged 30, had been married for feveral years, became pregnant, and mifcarried in the third month; the expulfion of the abortion occafioned fo fevere a ftrefs, as actually to lacerate the perinæum. Some time after her recovery, fhe was irregular, afterwards had one fhew of the menfes, again conceived, and the child, as fhe imagined, arrived at full time. She was attacked on Monday the 3d of January 1774, about midnight, with labour-pains, which went on flowly, gradually increafing till Saturday the 15th, when fhe was brought from the country to the Royal Infirmary here. Upon examination, the pelvis feemed confiderably diftorted; but the body was otherwife well fhaped, though of fmall fize; the os externum vaginæ was entirely fhut up, nor could any veftige of vagina be obferved, nor any appearance of labia pudendorum: inftead of this, there was a fmall aperture at the fuperior part of the vulva, immediately under the mons veneris, probably about the middle anterior part of the fymphyfis pubis. This aperture (which had a fmall procefs on the fuperior part, fomewhat refembling the clitoris) was no larger than juft to allow the introduction of a finger; the meatus urinarius lay concealed within it: a confulation of furgeons was called, and the Cæfarian fection was determined on. Having had no ftool, nor voided any urine for two days, an injection was attempted to be thrown up; but it did not pafs, nor was it poffible to pufh the female catheter into the bladder. Mr William Chalmer was the operator in this cafe. At fix in the evening, he made an incifion on the left fide of the abdomen in the ordinary way, through the integuments, till the peritonæum was expofed; two fmall arteries fprung, which were foon ftopped by a flight compreffion: the wound was then continued through the peritonæum into the cavity of the abdomen, when the bladder appeared, flightly inflamed, much diftended, reaching with its fundus near as far as the fcrobiculus cordis: another unfuccefsful attempt was made to pafs the female catheter; at length a male catheter was procured, which was, after fome difficulty, introduced into the bladder, and the urine evacuated to the quantity of above four pounds, high-fmelled and fetid. This occafioned a neceffary interruption for a few minutes, between making the opening into the abdomen and uterus; the bladder collapfing, the uterus, which before lay concealed, now came in view, through which an incifion was made, and a ftout male child was extracted alive; and immediately afterwards the fecundines. The uterns contracted rapidly. After cleanfing the wound, the lips were brought together by the quill-future, and dreffed

dreffed fuperficially. The patient fupported the operation with furprifing courage and refolution; nor was there more than five or fix ounces of blood loft on the occafion.

Being laid in bed, fhe complained of ficknefs, and had a flight fit of vomiting; but, by means of an anodyne, thefe fymptoms foon abated: fhe was affected with univerfal coldnefs over her body, which alfo abated on the application of warm irons to the feet: fhe then became eafy, and flept for four or five hours. Next morning, the 16th, about two o'clock, fhe complained of confiderable pain in the oppofite fide, for which fhe was blooded; and an injection was given, but without effect; for the pain increafed, ftretching from the right fide to the fcrobiculus cordis; nor did fomentations feem to relieve her; her pulfe became frequent, fhe was hot, and complained of drought. At 7 A. M. the injection was repeated, but with no better fuccefs; and eight ounces more of blood were taken from the arm; a third injection ftill failed to evacuate any fæces; the drought increafed; and the pulfe rofe to 128 ftrokes in a minute. At 11 A. M. the pulfe became fuller; and the refpiration much oppreffed. No ftool nor urine paffed fince the operation. At 12 fhe was blooded again, when the fizinefs appeared lefs than formerly. She now took a folution of *fal Glauber, manna and cr. tart.* at fhort intervals; fhe vomited a little after the laft dofe, had a foft ftool, and voided a fmall quantity of urine. At 3 P. M. her pulfe was 136, and fhe had another ftool, when thin fæces were evacuated; fhe was then ordered two fpoonfuls of a cordial anodyne mixture every fecond hour: the vomiting now abated; the pulfe became fmaller and more frequent; fhe paffed urine freely; but the pain and oppreffed breathing increafed. At feven P. M. her pulfe rofe to 142, and became weak and fluttering; fhe called for bread, and fwallowed a little with fome difficulty; her drought was intenfe; the dyfpnœa ftill increafed. She was now much oppreffed, and began to tofs; the pulfe funk and became imperceptible; fhe complained of faintifhnefs, but on belching wind her breathing was relieved, and the pulfe returned, growing fuller and ftronger: the pain of the fide ftill increafing, 12 ounces of blood, very fizy, were taken away; and two glyfters of warm water with oil were injected without effect: at 8 P. M. the pulfe became lefs frequent and fmaller; fhe complained much of the pain towards the fcrobiculus cordis; her breathing was much oppreffed; her belly was tenfe, and fwelled as big as before the operation; her pulfe was now fmall and feeble; fhe looked ghaftly; and expired a little after eight, 26 hours after the operation.

It is to be regretted that the relations would not permit the body to be opened.

Since the firft certain accounts of the operation fuccefsfully practifed by a fow-gelder on his own wife, in the beginning of the 16th century, there are on record above 70 well-attefted hiftories, wherein it has been fuccefsfully performed: for, of all the cafes related by authors, it has not proved fatal to the patient above once in ten or nine inftances; which evidently fhews the propriety of the practice, and probability of fuccefs, both in regard to the mother's own recovery, and for certainly preferving the life of the child. But it fhould never be attempted, excepting in thofe cafes only where it is abfolutely impoffible to deliver the woman by any other means whatever; for there are pelvifes to be met with, where, without having recourfe to this operation, both mother and child muft inevitably perifh: fuch have occurred to many practitioners, who, from want of refolution, or from ill-founded prejudice, have allowed their patients to perifh from neglect, contrary to a well known maxim in phyfic, That in a defperate cafe, it is better to employ a doubtful, and even defperate remedy, than to abandon the patient to certain and utter ruin. Such, for inftance, is a cafe related by Saviard, of a girl aged 27, whofe ftature was only three feet, who came to lie in at Paris, in the *Hotel Dieu;* every method but the operation was in vain attempted; both mother and child died. Mauriceau alfo relates the hiftory of a woman who was left to die, where the aperture of the pelvis was fo fmall as not to admit the hand of the accoucheur. And, not to multiply inftances, Mr De la Roche gives a cafe where the woman had been feven days in labour; the child was faved by the operation; but the woman died the fifth day after, probably from its being too long delayed: the diftance, in this fubject, from the lower vertebra lumborum and os pubis, was no more than two fingers breadth. The operation, when the neceffity is evident, ought therefore to be early performed, that the patient, who from her make and conftitution is generally delicate and puny may have every chance of recovery in her favour, without being exhaufted by the fruitlefs efforts of a tedious and painful labour, as too often has been the cafe. On thefe occafions, the prudent accoucheur fhould call in the advice of his elder brethren of the profeffion, and, by his cautious and prudent conduct, avoid every caufe of cenfure or reproach.

Exoftofes from the bones of the pelvis is a fpecies of deformity very rarely met with in practice, and which feldom or never takes place to fuch a degree as to render this operation neceffary.

II. Conftriction, callofity, tumours, &c. about the vagina or os tincæ. The vagina and os tincæ are often affected with conftrictions from cicatrices, with callofities and tumours; but it is feldom, if ever, neceffary to perform the Cæfarean fection on this account. Tumours in the vagina many generally be removed with fafety, even after the commencement of labour, and delivery happily fucceed; or it may be fometimes practicable for the accoucheur to pafs his hand by the fide of the tumour, to turn the child, and deliver. With regard to conftrictions in the vagina, and callofities in the os uteri, there are many inftances where, at the commencement of labour, it was impoffible to introduce a finger into the vagina; yet the parts have dilated as labour increafed, and the delivery terminated happily. At other times, the dilatation has begun during pregnancy, and been completed before delivery. There is a hiftory, for inftance, in the *Mem. de l'Acad. des Scienc.* 1712, of a woman whofe vagina was no larger than to admit a common writing quill; fhe had been married at 16, and conceived 11 years after: towards the fifth month of her pregnancy, the vagina began to dilate, and continued to do fo till full time, when fhe was fafely delivered. Guilemeau dilated, and La Mott extirpated callofities in the vagina and os tincæ, when the children were fuccefsfully expelled:

expelled by the force of natural labour.

Harvey relates a cafe where the whole vagina was grown together with cicatrices; nature, after a tedious labour, made the dilatation, and a large child was born.

La Mott mentions his having delivered three women, who had not the fmalleft veftige of an orifice through the vagina to the uterus. Dr Simpfon cut through a callofity of an os uteri which was half an inch thick, &c.

Upon the whole, tumours in the vagina, or about the orificium uteri, may be fafely extirpated without danger of hæmorrhagy or other fatal fymptoms, and the delivery will happily fucceed: and if the vagina be impervious, the os externum fhut up, or the labia grown together, the parts fhould be opened with the fcalpel, rather than rifk an operation, at beft in the iffue doubtful and precarious; an operation never allowable in fuch cafes, and therefore univerfally improper in difeafes or malconformation of the foft parts of generation. If the os externum be entirely clofed, if the cavity of the vagina be entirely filled up, or the paffage confiderably obftructed by tumours, callofity, or conftriction from cicatrice, and there is no reafon to fufpect a fault in the pelvis, of which a judgment may be formed by the common marks of deformity, under fize, or a ricketty habit; it is by much the beft practice to open a paffage through the vagina, and deliver the woman in the ordinary way. If there be no defect in the pelvis, the head of the child, or any other bulky part that prefents, will advance in this direction, till it meets with a refiftance in the foft parts: thus the teguments will at length be protruded before the child's head, in form of a tumour, when a fimple incifion downwards to the perinæum, in the direction of the anus, will remove the caufe of difficulty, by relieving the head; the child will afterwards fafely pafs, and the wound will heal without any bad confequence.

The ftate of the pelvis, and progrefs of the labour in thefe cafes, may often be learned by the touch of the finger in ano.

III. Lacerated uterus is another caufe for which this operation has been recommended. The uterus may be ruptured from violence in making the delivery; or fuch an accident may happen naturally, either from the crofs prefentation of the child in time of pregnancy, or in time of labour, when the pelvis is narrow: thefe cafes are generally fatal; and it is very feldom, if ever, that the life of the mother can be faved by the Cæfarian fection, after the fœtus efcapes through the torn uterus into the cavity of the abdomen; becaufe it often happens, that inflammation and fphacelus has affected the parts of the uterus that fuftained the preffure previous to the rupture; or, if otherwife, convulfions or other fatal fymptoms foon enfue, from the quantity of blood, waters, &c. poured into the cavity of the abdomen.

When the child cannot be extracted by the natural paffages, tremours, fingultus, cold fweats, fyncope, and the death of the mother, for the moft part, fo quickly follow, that it will at leaft feem doubtful, to a prudent humane practitioner, how far it would be advifeable, after fo dreadful an accident, the woman apparently in the agonies of death, rafhly to perform another dangerous operation, even with a view to preferve the child, till he had waited till the mother recruits or expires.

If part of the child be contained within the uterus, and the feet can be reached, the practice is to deliver by the orifice of the womb: but when the whole fœtus has efcaped entirely without the uterus, the Cæfarean operation is recommended as the only means of preferving both mother and child.

If the operation on this occafion be ever allowable, it may be afked,

1. At what time muft it be performed?

2. Would it not have the appearance of inhumanity to have recourfe to this expedient immediately after the uterus burfts, when the woman is feemingly ready to expire, although it be the only time when there is a chance of faving the child?

3. In moft cafes where this accident happens, fhould the Cæfarean fection be made, is it not highly improbable that the mother will furvive fo terrible a laceration?

4. For if it be done with a view to fave the mother, in what manner is the extravafated blood, &c. to be evacuated from the cavity of the abdomen?

What feems to make cafes of this kind unfavourable, when the accident happens in time of labour, is,

1*mo*, That here, the parts before rupture, in moft cafes, are in a gangrenous ftate.

2*do*, As the rupture is commonly towards the cervix, there is generally a much greater hæmorrhagy by reafon of the flow contraction of the uterus at this place.

3*tio*, The uncertainty, whether, or how long, the patient will furvive it, feems alfo a confiderable obftacle to the operation under fuch difagreeable circumftances, *Ne occidiffe videatur, quem fors interemit.*

IV. Ventral conceptions is a fourth indication for this operation. Thefe are either in the ovaria, tubes, or cavity of the abdomen, and feldom arrive at great fize; or are retained, very often a long time, without occafioning much complaint. The iffue of thefe conceptions has alfo been no lefs various than extraordinary; for after being retained for a great many years in an indolent ftate, at length abfceffes or ulcerations have formed, and they have been difcharged through all the different parts of the abdomen.

Moft women feel pain and violent motion at the time of ordinary delivery in thefe cafes of ventral conception; if therefore the operation be ever neceffary, now is the proper time to perform it. But in general, as the feparation of extra-uterine fœtufes from their involucra, may occafion immediate death in many cafes, from the vaft hæmorrhagy that might enfue from the non-contractile power of the parts to which they adhere; unlefs they point outwardly, or excite the moft violent fymptoms, they ought univerfally to be left to nature.

V. Herniæ of the uterus are feldom or never fufficient to induce us to perform the Cæfarian fection, as the uterus is very rarely influenced in fuch a manner, that the orifice cannot be reached, and the delivery fuccefsfully made. Many inftances are to be found among furgical authors, where deliveries, under fuch circumftances, have been happily performed, without having recourfe to fo hazardous an expedient. Thus Mauriceau mentions a cafe, where the uterus, in a ventral hernia, was pufhed along with the inteftines above the hernia

belly, and contained in a tumour of a prodigious ſize; the woman, however, was delivered at the end of her time, in the ordinary way. La Mott relates the hiſtory of a woman in a preternatural labour, whoſe uterus and child hung down pendulous to the middle of her thigh, but whom, notwithſtanding, he ſafely delivered: and Ruyſch gives a caſe where the midwife reduced the hernia before delivery; although it was prolapſed as far as the knee, the delivery was ſafely performed, and the woman had a good recovery.

Laſtly, The poſition or bulk of the child.

Since the practice of turning the child and delivering by the feet, and the late improvement of obſtetrical inſtruments, this operation is never to be performed on account of poſition, monſtroſity, or any other obſtacle on the part of the child.

Upon the whole, when the pelvis is faulty to ſuch a degree, that no inſtrument can be conducted to tear and extract the child, this perhaps is the only caſe wherein this operation ſhould be performed on the living ſubject. Inciſions through the teguments of the abdomen to extract extra-uterine fœtuſes, or bones of fœtuſes, do not properly fall under the name of *Cæſarean ſection*, as that name implies inciſion of the uterus alſo.

When a woman advanced in pregnancy dies ſuddenly, either by accident or by natural diſeaſe, the Cæſarean ſection is recommended as an expedient to preſerve the life of the child. This is a very proper meaſure, provided the death of the mother be aſcertained; but ſometimes it is a very nice and difficult point to diſtinguiſh between a deliquium and death; and therefore the accoucheur, on ſuch an occaſion, muſt act with the utmoſt circumſpection. If the operation be delayed but a very ſhort while after the mother expires, it will probably be in vain to make the attempt; for, whatever fabulous ſtories may be related to the contrary, there are few authentic caſes of the fœtus of any animal ſurviving the mother, perhaps an hour; and therefore every thing ſhould be in readineſs to extract the child with all poſſible expedition, after the event of the mother's death. But, in ſuch caſes, the agonies of death often perform the part of labour, and the child is ſometimes thrown off *in articulo mortis;* or the os uteri is ſo much dilated, that there is eaſy acceſs to paſs the hand, turn the child, and deliver. Thus one ſhould be very cautious in having recourſe to this operation, even in the above circumſtances; which ſhould never be done,

1. Till the death of the mother be aſcertained beyond doubt;

2. Till the ſtate of the os uteri be examined;

3. Till the conſent of the relations be obtained; And,

Laſtly, It need not be undertaken, except where the mother dies ſuddenly, between the 7th and 9th month.

It is unneceſſary where the diſeaſe has been lingering; in ſuch caſes the child commonly dies before the mother.

When it is doubtful whether the child be alive or not, it may be determined by applying the hand on the abdomen of the mother about the time of, and for a little while after, her death, when the life of the child will be diſcovered by its motions and ſtruggling.

Thus having pointed out the different cauſes that determine this operation, it may be obſerved, that it is a frightful and hazardous one; and although performed ſucceſsfully in a number of caſes, yet, in many others, it has failed, and the woman has died either immediately or ſoon after. It ſhould never, therefore, be undertaken but on extraordinary and deſperate occaſions; and then it is not only adviſeable, but incumbent on every practitioner to whom ſuch caſes occur.

To conclude, it may not be improper to give a few directions with regard to the method of performing the operation on the living ſubject.

Having emptied the bladder, and evacuated the contents of the inteſtines with repeated emollient glyſters; the patient being encouraged, with proper cordials, and every other requiſite in readineſs, ſhe muſt be placed on a table or bed, with her left ſide gently raiſed with pillows or bolſters, and properly ſecured by aſſiſtants. An inciſion muſt be made with a common convex ſcalpel, beginning rather below the navel at the middle ſpace between it and the ſpine of the os ilium, carrying it obliquely forwards towards this bone, ſo that the wound in length may exceed ſix inches. This external wound is to be carried through the common teguments of the abdomen till the peritonæum is expoſed, when the operator ſhould reſt a little, till the hæmorrhage be entirely abated. He muſt then, with great caution, make a ſmall opening through this membrane, introduce his finger, and upon this a ſcalpel (which is preferable to ſciſſars), and with great expedition make a complete dilatation; he muſt now wipe away the blood with a ſpunge, preſs the omentum or inteſtines gently to a ſide, if in the way, and endeavour to diſcover to what part of the uterus the placenta adheres, that it may be avoided in making the inciſion. This may eaſily be known by a thickneſs and ſolidity in the part, which diſtinguiſh it from the reſt of the uterus; it is ſtill more eaſily diſcovered when the membranes are entire. The blood-veſſels are leſs in number, and ſmalleſt in the middle and interior part of the uterus, which therefore, if the placenta does not interfere, is the proper place for making the inciſion, which muſt be performed with the utmoſt attention leſt the child ſhould be wounded: if the membranes are entire, more freedom may be uſed, and *vice verſa*. The direction and length of the wound of the uterus muſt be the ſame with the external one. The child muſt now be quickly extracted, and the placenta carefully ſeparated: theſe muſt be given to an aſſiſtant, who will divide the chord, and take care of the child, as the operator's attention muſt be wholly beſtowed on the mother. The coagulated blood, &c. being removed by a ſpunge wrung out of warm water, (leſt the uterus or inteſtines be protruded, which are very troubleſome to reduce), the lips of the external wound muſt be quickly brought together, and retained by an aſſiſtant till ſecured by a few ſtitches; generally three will be ſufficient: as many needles ſhould be ready threeded with pretty large broad ligatures; the middle ſtitch ought to be made firſt; the needle ſhould be introduced at a proper diſtance, i. e. about an inch and one-fourth from the ſide of the wound, carrying

Cæfarean Operation.

it firft from without inwards, and then from within outwards, fecuring with a double flip a knot, to be ready to untie, left violent tenfion or inflammation fhould enfue; under the knot a foft comprefs of lint, fharpee, or rolled plafter, fhould be applied, and the whole dreffings muft be fecured by a proper comprefs and bandage. The patient muft be afterwards treated in the fame manner as after lithotomy, or any other capital operation.

Quæritur, To what caufe is the unfuccefsful event of this operation to be imputed? When the operation proves fatal, to what immediate caufe are we to afcribe the death of the patient? Is it nervous, or uterine irritation, from cutting, that kills? Is it internal hæmorrhage, or the extravafation of fluids into the cavity of the abdomen? Or are not the fatal confequences rather to be imputed to the accefs of the air on the irritable vifcera? This can only therefore be prevented by expofing thefe parts for as fhort a fpace of time as poffible. Dr Mouro, the prefent anatomical profeffor at Edinburgh, in making experiments on young fmall animals, fuch as bitches, cats, frogs, &c. by opening the cavity of the abdomen, and tying the biliary ducts, remarks, that though a large opening into the abdomen be made by incifion, if the wound be quickly clofed and ftitched, the animal will recover, and no bad confequences follow; but if expofed a few minutes to the air, dreadful pain foon comes on, which the creature expreffes by the fevereft agonies; convulfions at laft enfue, and death within four or fix hours after the operation. On opening the abdomen after death, the whole vifcera are found to be in an inflamed ftate, and univerfally adhering to one another. He has often repeated the experiment, and the fame appearances as often take place.

May not the analogy here juftly apply to the human fubject? And, in performing the Cæfarean operation, fhould we not be very careful that the vifcera be expofed as little as poffible, and that the wound be covered with the utmoft poffible expedition?

The ill fuccefs which generally attends the Cæfarean operation fome years ago, induced fome French practitioners to try a new method of extracting the child when, through the narrownefs of the pelvis, or any other caufe, it is impoffible to deliver the woman either naturally or by means of inftruments. This was by cutting the fymphyfis of the os pubis; by which operation it was thought that the bones would feparate to a fufficient degree to make room for the paffage of the child. This operation is found not to be fo fatal in itfelf as the Cæfarean fection; but unhappily it doth not promife with any certainty to afford the neceffary relief to the woman. Dr Vaughan remarks, 1. That it is extremely difficult to execute it with a thick knife, however fharp in the edge. The ligamentous and griftly fubftance between the bones is fo incompreffible that it will hardly make room for the thicker part of the knife to follow its edge; but a thin knife goes through it with great eafe.

2. Whoever has had a little practice, will find, that it may be executed without any danger of wounding the bladder or urethra; becaufe, in cutting cautioufly with a thin knife, from above downwards and inwards, the inftant that the whole is cut through, there is both a particular found, which informs us that the bufinefs is done, and the two bones fly afunder to a fenfible diftance.

3. When the fymphyfis is completely divided, the offa pubis feparate fo little a way, that fome force is neceffary to produce an interval of half an inch; and upon increafing the force till the fpace of interval comes to two inches and an half, there is a continued crafh, from the tearing of the ligamentous fibres at the pofterior joints, viz at the fides of the facrum. This, though requiring great force, is eafily affected, by bringing the thighs to right angles with the trunk of the body, and preffing the knees gradually outwards and backwards. In that way, a fmall force has a great effect, becaufe it has the advantage of a long lever, and is affifted by almoft the whole weight of the lower extremities.

4. When fuch a violent feparation of the offa pubis has been produced, the facrum and offa innominata remain in contact only at their pofterior parts; the ligaments that connect them at the fore-part being all, more or lefs, torn afunder.

5. The mifchief that may enfue upon cutting one joint of the pelvis, and tearing the other two afunder, can be afcertained by experience only. It is propofed, that the incifion at the pubes fhall not penetrate into the cavity of the abdomen. If, by accident, that fhould happen, the operation would of courfe be very dangerous. Lacerations of tendons, ligaments, and flefhy parts, when not complicated with an external wound, generally heal up in a kindly manner, as we fee in cafes of the ruptured tendo achillis, diflocations, and fractures.

But, on the other hand, at the time of parturition, the body is remarkably difpofed to an inflammatory fever, which is alway very dangerous when it rifes to any height; and therefore, whatever expofes the body to confiderable inflammation at that time, we may prefume, muft be attended with fome danger. And it muft likewife be remembered, that women who are exceedingly crooked, are commonly fo weak that they eafily fink under any great difeafe.

At the fame time our author allows, that the Cæfarean fection, though it may fave the child, yet will almoft always be fatal to the mother. The cutting of the fymphyfis, on the other hand, hath no probability of faving the child, and the effect on the mother muft be doubtful. He indeed gives no inftance of the bad fuccefs of the cutting the fymphyfis, though he gives an additional one of the fatality of the Cæfarean operation. As a decifive proof of the inefficacy of the cutting the fymphyfis to fave the child, he gives the figures of the diftorted pelvis of two women; by which it appears, that the utmoft dilatation ufed by this means could have amounted to no more than to enlarge the paffage to a circle of two inches and a quarter, which is not at all fufficient to afford an exit to a living child. In all cafes therefore, when the mother cannot be delivered without deftroying the child, he gives the preference to the crotchet; after the ufe of which, he fays, if the operation is flowly performed, by allowing intervals of eafe, as in the natural labour, women recover almoft as foon as in other cafes. Yet, notwithftanding all that can be argued againft this operation, it is plain, that as it gives

Management after Delivery.

gives a probable chance of faving the mother's life, though at the expence of the child, it ought always to be preferred to the Cæfarean fection, which faves the child, but deftroys the mother. Neverthelefs, it would be fhocking to think of performing even this operation where there was a poffibility of accomplifhing the delivery by any other means.

Chap. XVI. *Of the Management of Women after delivery.*

The woman being delivered of the child and placenta, let a foft linen-cloth, warmed, be applied to the external parts; and if fhe complains much of a fmarting forenefs, fome pomatum may be fpread upon it. The linen that was laid below her, to fpunge up the difcharges, muft be removed, and replaced with others that are clean, dry, and warm. Let her lie on her back, with her legs extended clofe to each other; or upon her fide, if fhe thinks fhe can lie eafier in that pofition, until fhe recovers from the fatigue: if fhe is fpent and exhaufted, let her take a little warm wine or caudle, or, according to the common cuftom, fome nutmeg and fugar grated together in a fpoon: the principal defign of adminiftering this powder, which among the good women is feldom neglected, is to fupply the want of fome cordial draught, when the patient is too weak to be raifed, or fuppofed to be in danger of retchings from her ftomach's being overloaded. When fhe hath in fome meafure recovered her ftrength and fpirits, let the cloths be removed from the parts, and others applied in their room; and, if there is a large difcharge from the uterus, let the wet linen below her be alfo fhifted, that fhe may not run the rifk of catching cold.

When the patient is either weak or faintifh, fhe ought not to be taken out of bed, or even raifed up to have her head and body fhifted, until fhe is a little recruited; otherwife fhe will be in danger of repeated faintings, attended with convulfions, which fometimes end in death. To prevent thefe bad confequences, her fkirt and petticoats ought to be loofened and pulled down over the legs, and replaced by another well warmed, with a broad head-band to be flipt in below, and brought up over her thighs and hips: a warm double cloth muft be laid on the belly, which is to be furrounded by the head-band of the fkirt pinned moderately tight over the cloth, in order to comprefs the vifcera and the relaxed parietes of the abdomen, more or lefs, as the woman can eafily bear it; by which means the uterus is kept firm in the lower part of the abdomen, and prevented from rolling from fide to fide when the patient is turned: but the principal end of this compreffion is to hinder too great a quantity of blood from rufhing into the relaxed veffels of the abdominal contents, efpecially when the uterus is emptied all of a fudden by a quick delivery. The preffure being thus fuddenly removed, the head is all at once robbed of its proportion of blood, and the immediate revulfion precipitates the patient into dangerous lypothymia.

For this reafon the belly ought to be firmly compreffed by the hands of an affiftant, until the bandage is applied; or, in lieu of it, a long towel, fheet, or roller, to make a fuitable compreffion: but for this purpofe different methods are ufed in different countries, or according to the different circumftances of the patients. The head-cloaths and fhift ought alfo to be changed, becaufe with fweating in time of labour they are rendered wet and difagreeable. Several other applications are neceffary, when the external or internal parts are rent or inflamed, misfortunes that fometimes happen in laborious and preternatural cafes.—We fhall conclude this chapter with giving fome neceffary directions with regard to air, diet, &c.

Although we cannot remove the patient immediately after delivery into another climate, we can qualify the air fo as to keep it in a moderate and falutary temper, by rendering it warm or cold, moift or dry, according to the circumftances of the occafion. With regard to diet, women, in time of labour, and even till the ninth day after delivery, ought to eat little folid food, and none at all during the firft five or feven: let them drink plentifully of warm diluting fluids, fuch as barley-water, gruel, chicken-water, and teas; caudles are alfo commonly ufed, compofed of water-gruel boiled up with mace and cinnamon, to which, when ftrained, is added a third or fourth part of white wine, or lefs, if the patient drinks plentifully, fweetened with fugar to their tafte: this compofition is termed *white caudle;* whereas, if ale is ufed inftead of wine, it goes under the name of *brown caudle.* In fome countries, eggs are added to both kinds; but, in that cafe, the woman is not permitted to eat meat or broths till after the fifth or feventh day: in this country, however, as eggs are no part of the ingredients, the patient is indulged with weak broth fooner, and fometimes allowed to eat a little boiled chicken. But all thefe different preparations are to be prefcribed weaker or ftronger, with regard to the fpices, wine, or ale, according to the different conftitutions and fituations of different patients: for example, if fhe is low and weak, in confequence of an extraordinary difcharge of any kind, either before or after delivery, or if the weather is cold, the caudles and broths may be made the ftronger; but if fhe is of a full habit of body, and has the leaft tendency to a fever, or if the feafon is exceffively hot, thefe drinks ought to be of a very weak confiftence, or the patient reftricted to gruel, tea, barley and chicken water, and thefe varied according to the emergency of the cafe.

Her food muft be light and eafy of digeftion, fuch as panada, bifcuit, and fago; about the fifth or feventh day fhe may eat a little boiled chicken, or the lighteft kind of young meat; but thefe laft may be given fooner or later, according to the circumftances of the cafe and the appetite of the patient. In the regimen as to the eating and drinking, we fhould rather err on the abftemious fide than indulge the woman with meat and ftrong fermented liquors, even if thefe laft fhould be moft agreeable to her palate: for we find by experience, that they are apt to increafe or bring on fevers, and that the moft nourifhing and falutary diet is that which we have above prefcribed. Every thing that is difficult of digeftion, or quickens the circulating fluids, muft of neceffity promote a fever; by which the neceffary difcharges are obftructed, and the patient's life endangered.

Management after Delivery.

As to the article of fleeping and watching, the patient muft be kept as free from noife as poffible, by covering the floors and ftairs with carpets and cloths, oiling the hinges of the doors, filencing the bells, tying up the knockers, and in noify ftreets ftrowing the pavement with ftraw; if, notwithftanding thefe precautions, fhe is difturbed, her ears muft be ftuffed with cotton, and opiates adminiftered to procure fleep; becaufe watching makes her reftlefs, prevents perfpiration, and promotes a fever.

Motion and reft are another part of the nonnaturals to which we ought to pay particular regard. By toffing about, getting out of bed, or fitting up too long, the perfpiration is difcouraged and interrupted; and in this laft attitude the uterus, not yet fully contracted, hangs down, ftretching the ligaments, occafioning pain, cold fhiverings, and a fever: for the prevention of thefe bad fymptoms, the patient muft be kept quiet in bed till after the fourth or fifth day, and then be gently lifted up in the bed-cloaths, in a lying pofture, until the bed can be adjufted, into which fhe muft be immediately reconveyed, there to continue, for the moft part, till the ninth day, after which period women are not fo fubject to fevers as immediately after delivery. Some there are who, from the nature of their conftitutions, or other accidents, recover more flowly; and fuch are to be treated with the fame caution after as before the ninth day, as the cafe feems to indicate: others get up, walk about, and recover, in a much fhorter time; but thefe may fome time or other pay dearly for their foolhardinefs, by encouraging dangerous fevers: fo that we ought rather to err on the fafe fide than run any rifk whatfoever.

What next comes under confideration is the circumftance of retention and excretion. We have formerly obferved, that, in time of labour, before the head of the child is locked into the pelvis, if the woman has not had an eafy paffage in her belly that fame day, the rectum and colon ought to be emptied by a glyfter, which will affift the labour, prevent the difagreeable excretion of the fœces before the child's head, and enable the patient to remain two or three days after, without the neceffity of going to ftool. However, fhould this precaution be neglected, and the patient very coftive after delivery, we muft beware of throwing up ftimulating glyfters, or adminiftering ftrong cathartics, left they fhould bring on too many loofe ftools, which, if they cannot be ftopt, fometimes produce fatal confequences, by obftructing the perfpiration and lochia, and exhaufting the woman, fo as that fhe will die all of a fudden; a cataftrophe which hath frequently happened from this practice. Wherefore, if it be neceffary to empty the inteftines, we ought to prefcribe nothing but emollient glyfters, or fome very gentle opener, fuch as manna, or *elect. lenitivum.* But no excretion is of more confequence to the patient's recovery than a free perfpiration; which is fo abfolutely neceffary, that unlefs fhe has a moifture continually on the furface of her body, for fome days after the birth, fhe feldom recovers to advantage: her health, therefore, in a great meafure, depends upon her enjoying undifturbed repofe, and a conftant breathing fweat, which prevents a fever, by carrying off the tenfion, and affifts the equal difcharge of the lochia: and when thefe are obftructed, and a fever enfues with pain and reftleffnefs, nothing relieves the patient fo effectually as reft and profufe fweating, procured by opiates and fudorifics at the beginning of the complaints; yet thefe laft muft be more cautioufly prefcribed in exceffive hot than in cool weather.

The laft of the nonnaturals to be confidered are the paffions of the mind, which alfo require particular attention. The patient's imagination muft not be difturbed by the news of any extraordinary accident which may have happened to her family or friends: for fuch information hath been known to carry off the labour-pains entirely, after they were begun, and the woman has funk under her dejection of fpirits: and, even after delivery, thefe unfeafonable communications have produced fuch anxiety as obftructed all the neceffary excretions, and brought on a violent fever and convulfions, that ended in death.

Floodings.

Chap. XVII. *Of violent Floodings.*

All women, when the placenta feparates, and after it is delivered, lofe more or lefs red blood, from the quantity of half a pound to that of one pound, or even two; but fhould it exceed this proportion, and continue to flow without diminution, the patient is in great danger of her life: this hazardous hæmorrhage is known by the violence of the difcharge, wetting frefh cloaths as faft as they can be applied; from the pulfe becoming low and weak, and the countenance turning pale; then the extremities grow cold, fhe finks into faintings, and, if the difcharge is not fpeedily ftopped or diminifhed, is feized with convulfions, which often terminate in death.

This dangerous efflux is occafioned by every thing that hinders the emptied uterus from contracting, fuch as great weaknefs and laffitude, in confequence of repeated floodings before delivery; the fudden evacuation of the uterus; fometimes, though feldom, it proceeds from part of the placenta's being left in the womb; it may happen when there is another child, or more, ftill undelivered; when the womb is kept diftended with a large quantity of coagulated blood; or when it is inverted by pulling too forcibly at the placenta.

In this cafe, as there is no time to be loft, and internal medicines cannot act fo fuddenly as to anfwer the purpofe, we muft have immediate recourfe to external application. If the diforder be owing to weaknefs, by which the uterus is difabled from contracting itfelf, fo that the mouths of the veffels are left open; or, though contracted a little, yet not enough to reftrain the hæmorrhage of the thin blood; or if, in feparating the placenta, the accoucheur has fcratched or tore the inner furface or membrane of the womb; in thefe cafes, fuch things muft be ufed as will affift the contractile power of the uterus, and hinder the blood from flowing fo faft into it and the neighbouring veffels; for this purpofe, cloths dipped in any cold aftringent fluid, fuch as oxycrate, or red tart wine, may be applied to the back and belly. Some prefcribe venefection in the arm, to the amount of five or fix ounces, with a view of making revulfion: if the pulfe is ftrong, this may be proper; otherwife, it will do more harm than good. Others order ligatures, for compreffing the returning veins at the hams, arms, and

After-pains and neck, to retain as much blood as poſſible in the extremities and head. Beſides theſe applications, the vagina may be filled with tow or linen-rags, dipped in the abovementioned liquids, in which a little alum, or ſachar-ſaturni hath been diſſolved: nay, ſome practitioners inject proof-ſpirits warmed, or, ſoaking them up in a rag or ſpunge, introduce and ſqueeze them into the uterus, in order to conſtringe the veſſels.

If the flooding proceeds from another child, the retention of the placenta, or coagulated blood, theſe ought immediately to be extracted; and if there is an inverſion of the uterus, it muſt be ſpeedily reduced. Should the hæmorrhage, by theſe methods, abate a little, but ſtill continue to flow, though not in ſuch a quantity as to bring on ſudden death, ſome red wine and jelly ought to be preſcribed for the patient, who ſhould take it frequently, and a little at a time; but above all things chicken or mutton broths, adminiſtered in the ſame manner, for fear of overloading the weakened ſtomach, and occaſioning retchings: theſe repeated in ſmall quantities, will gradually fill the exhauſted veſſels, and keep up the circulation. If the pulſe continues ſtrong, it will be proper to order repeated draughts of barley-water, acidulated with elixir vitriol: but if the circulation be weak and languid, extract of the bark, diſſolved in *aq. cinnamomi tenuis*, and given in ſmall draughts, or exhibited in any other form, will be ſerviceable; at the ſame time, lulling the patient to reſt with opiates. Theſe, indeed, when the firſt violence of the flood is abated, if properly and cautiouſly uſed, are generally more effectual than any other medicine.

Chap. XVIII. *Of the After-pains.*

After-pains commonly happen when the fibrous part of the blood is retained in the uterus or vagina, and formed into large clots, which are detained by the ſudden contraction of the os internum and externum, after the placenta is delivered: or, if theſe ſhould be extracted, others will ſometimes be formed, tho' not ſo large as the firſt, becauſe the cavity of the womb is continually diminiſhing after the birth. The uterus, in contracting, preſſes down theſe coagulums to the os internum; which being again gradually ſtretched, produces a degree of labour-pains, owing to the irritation of its nerves: in conſequence of this uneaſineſs, the woman ſqueezes the womb as in real labour; the force being increaſed, the clots are puſhed along, and when they are delivered ſhe grows eaſy. The larger the quantity is of the coagulated blood, the ſeverer are the pains, and the longer they continue.

Women in the firſt child ſeldom have after-pains; becauſe, after delivery, the womb is ſuppoſed to contract; and puſh off the clots with greater force in the firſt than in the following labours: after-pains may alſo proceed from obſtructions in the veſſels, and irritations at the os internum. In order to prevent or remove theſe pains, as ſoon as the placenta is ſeparated and delivered, the hand being introduced into the uterus, may clear it of all the coagula. When the womb is felt through the parietes of the abdomen larger than uſual, it may be taken for granted that there is either another child, or a large quantity of this clotted blood; and, which ſoever it may be, there is a neceſſity for its being extracted. If the placenta comes away of itſelf, and the after-pains are violent, they may be alleviated and carried off by an opiate: for, by ſleeping and ſweating plentifully, the irritation is removed, the evacuations are increaſed, the os uteri is inſenſibly relaxed, and the coagula ſlide eaſily along. When the diſcharge of the lochia is ſmall, the after-pains, if moderate, ought not to be reſtrained; becauſe the ſqueezing which they occaſion promotes the other evacuation, which is neceſſary for the recovery of the patient. After-pains may alſo proceed from an obſtruction in ſome of the veſſels, occaſioning a ſmall inflammation of the os internum and ligaments; and the ſqueezing thereby occaſioned may not only help to propel the obſtructing fluid, but alſo (if not too violent) contribute to the natural diſcharges.

Chap. XIX. *Of the Lochia.*

Lochia.

We have already obſerved, that the delivery of the child and placenta is followed by an efflux of more or leſs blood, diſcharged from the uterus, which, by the immediate evacuation of the large veſſels, is allowed to contract itſelf the more freely, without the danger of an inflammation, which would probably happen in the contraction, if the great veſſels were not emptied at the ſame time: but as the fluids in the ſmaller veſſels cannot be ſo ſoon evacuated, or returned into the vena cava, it is neceſſary that, after the great diſcharge is abated, a ſlow and gradual evacuation ſhould continue, until the womb ſhall be contracted to near the ſame ſize which it had before pregnancy; and to this it attains about the 18th or 20th day after delivery, though the period is different in different women.

When the large veſſels are emptied immediately after delivery, the diſcharge frequently ceaſes for ſeveral hours, until the fluids in the ſmaller veſſels are propelled into the larger, and then begins to flow again, of a paler colour.

The red colour of the lochia commonly continues till the fifth day, though it is always turning more and more ſerous from the beginning: but, about the fifth day, it flows off a clear, or ſometimes (though ſeldom) of a greeniſh tint; for, the mouths of the veſſels growing gradually narrower by the contraction of the uterus, at laſt allow the ſerous part only to paſs: as for the greeniſh hue, it is ſuppoſed to proceed from a diſſolution of the cellular or cribriform membrane or mucus, that ſurrounded the ſurface of the placenta and chorion; part of which, being left in the uterus, becomes livid, decays, and, diſſolving, mixes with and tinctures the diſcharge as it paſſes along.

Though the lochia, as we have already obſerved, commonly continue till the 18th or 20th day, they are every day diminiſhing in quantity, and ſooneſt ceaſe in thoſe women who ſuckle their children, or have had an extraordinary diſcharge at firſt; but the colour, quantity, and duration, differ in different women: in ſome patients, the red colour diſappears on the firſt or ſecond day; and in others, though rarely, it continues more or leſs to the end of the month: the evacuation in ſome is very ſmall, in others exceſſive: in one woman it ceaſes very ſoon, in another flows during

Milk fever. during the whole month: yet all of thefe patients fhall do well.

Some allege, that this difcharge from the uterus is the fame with that from a wound of a large furface; but it is more reafonable to fuppofe, that the change of colour and diminution of quantity proceed from the flow contraction of the veffels; becaufe, previous to pus, there muft have been lacerations and impofthumes, and, in women who have fuddenly died after delivery, no wound or excoriation hath appeared upon the inner furface of the womb, which is fometimes found altogether fmooth, and at other times rough and unequal, on that part to which the placenta adhered. The fpace that is occupied before the delivery, from being fix inches in diameter, or 18 inches in circumference, will, foon after the birth, be contracted to one third or fourth of thefe dimenfions.

Chap. XX. *Of the Milk-fever.*

About the fourth day, the breafts generally begin to grow turgid and painful. We have formerly obferved, that, during the time of uterine geftation, the breafts in moft women gradually increafe till the delivery, growing fofter as they are enlarged by the veffels being more and more filled with fluids; and by this gradual diftenfion they are prepared for fecreting the milk from the blood after delivery. During the two or three firft days after parturition, efpecially when the woman has undergone a large difcharge, the breafts have been fometimes obferved to fubfide and grow flaccid; and about the 3d or 4th day, when the lochia begin to decreafe, the breafts fwell again to their former fize, and ftretch more and more, until the milk, being fecreted, is either fucked by the child, or frequently of itfelf runs out at the nipples.

Moft of the complaints incident to women after delivery, proceed either from the obftruction of the lochia in the uterus, or of the milk in the breafts, occafioned by any thing that will produce a fever; fuch as catching cold, long and fevere labour, eating food that is hard of digeftion, and drinking fluids that quicken the circulation of the blood in the large veffels; by which means the fmaller, with all the fecretory and excretory ducts, are obftructed.

The difcharge of the lochia being fo different in women of different conftitutions, and befides in fome meafure depending upon the method of management, and the way of life peculiar to the patient, we are not to judge of her fituation from the colour, quantity, and duration of them, but from the other fymptoms that attend the difcharge; and if the woman feems hearty, and in a fair way of recovery, nothing ought to be done with a view to augment or diminifh the evacuation. If the difcharge be greater than fhe can bear, it will be attended with all the fymptoms of inanition; but as the lochia feldom flow fo violently as to deftroy the patient of a fudden, fhe may be fupported by a proper nourifhing diet, affifted with cordial and reftorative medicines. Let her, for example, ufe broths, jellies, and affes milk; if the pulfe is languid and funk, fhe may take repeated dofes of the *confect. cardiac.* with mixtures compofed of the cordial waters and volatile fpirits: fubaftringents and opiates frequently adminiftered, with the *cort. Peruvian.* in different forms, and auftere wines, are of great fervice. Milk-fever. On the other hand, when the difcharge is too fmall, or hath ceafed altogether, the fymptoms are more dangerous, and require the contrary method of cure: for now the bufinefs is to remove a too great plenitude of the veffels in and about the uterus, occafioning tenfion, pain, and labour, in the circulating fluids; from whence proceed great heat in the part, reftlefsnefs, fever, a full, hard, quick pulfe, pains in the head and back, naufea, and difficulty in breathing. Thefe complaints, if not at firft prevented, or removed by reft and plentiful fweating, muft be treated with venefection and the antiphlogiftic method.

When the obftruction is recent, let the patient lie quiet, and encourage a plentiful diaphorefis, by drinking frequently of warm, weak, diluting fluids, fuch as water-gruel, barley-water, tea, or weak chickenbroth.

Should thefe methods be ufed without fuccefs, and the patient, far from being relieved by reft, plentiful fweating, or a fufficient difcharge of the obftructed lochia, labour under an hot, dry fkin, anxiety, and a quick, hard, and full pulfe, the warm diaphoretics muft be laid afide; becaufe, if they fail of having the defired effect, they muft neceffarily increafe the fever and obftruction, and recourfe be had to bleeding at the arm or ankle to more or lefs quantity, according to the degree of fever and obftruction; and this evacuation muft be repeated as there is occafion. When the obftruction is not total, it is fuppofed more proper to bleed at the ankle than at the arm; and at this laft, when the difcharge is altogether ftopped, her ordinary drink ought to be impregnated with nitre.

If fhe is coftive, emollient and gently opening glyfters may be occafionally injected; and her breafts muft be fomented and fucked, either by the mouth or pipe-glaffes. If by thefe means the fever is abated, and the neceffary difcharges return, the patient commonly recovers; but if the complaints continue, the antiphlogiftic method muft ftill be purfued. If, notwithftanding thefe efforts, the fever is not diminifhed or removed by a plentiful difcharge of the lochia from the uterus, the milk from the breafts, or by a critical evacuation by fweat, urine, or ftool, and the woman is every now and then attacked with cold fhiverings; an abfcefs or abfceffes will probably be formed in the uterus or neighbouring parts, or in the breafts; and fometimes the matter will be tranflated to other fituations, and the feat of it foretold from the part's being affected with violent pains: thefe abfceffes are more or lefs dangerous, according to the place in which they happen, the largenefs of the fuppuration, and the good or bad conftitution of the patient.

If, when the pains in the epigaftric region is violent, and the fever increafed to a very high degree, the patient fhould all of a fudden enjoy a ceffation from pain, without any previous difcharge or critical eruption, the phyfician may pronounce that a mortification is begun; efpecially if, at the fame time, the pulfe becomes low, quick, wavering, and intermitting: if the woman's countenance, from being florid, turns dufky and pale, while fhe herfelf, and all the attendants, conceive her much mended; in that cafe, fhe will grow delirious,

Milk-fever. rious, and die in a very short time.

What we have said on this subject regards that fever which proceeds from the obstructed lochia, and in which the breasts may likewise be affected: but the milk-fever is that in which the breasts are originally concerned, and which may happen tho' the lochia continue to flow in sufficient quantity; nevertheless, they mutually promote each other, and both are to be treated in the manner already explained; namely, by opiates, diluents, and diaphoretics, in the beginning; and, these prescriptions failing, the obstructions must be resolved by the antiphlogistic method described above. The milk-fever alone, when the uterus is not concerned, is not so dangerous, and much more easily relieved. Women of an healthy constitution, who suckle their own children, have good nipples, and whose milk comes freely, are seldom or never subject to this disorder, which is more incident to those who do not give suck, and neglect to prevent the secretion in time; or, when the milk is secreted, take no measures for emptying their breasts. This fever likewise happens to women who try too soon to suckle, and continue their efforts too long at one time; by which means the nipples, and consequently the breasts, are often inflamed, swelled, and obstructed.

In order to prevent a too great turgency in the vessels of the breasts, and the secretion of milk, in those women who do not choose to suckle, it will be proper to make external application of those things which, by their pressure and repercussive force, will hinder the blood from flowing in too great quantity to this part, which is now more yielding than at any other time: for this purpose, let the breasts be covered with *emp. de minia*, *diapalma*, or *emp. simp.* spread upon linen, or cloths dipped in camphorated spirits, be frequently applied to these parts and the arm-pits; while the patient's diet and drink is of the lightest kind, and given in small quantities. Notwithstanding these precautions, a turgency commonly begins about the third day; but by rest, moderate sweating, and the use of these applications, the tension and pain will subside about the fifth or sixth day, especially if the milk runs out at the nipples: but if the woman catches cold, or is of a full habit of body, and not very abstemious, the tension and pain increasing, will bring on a cold shivering succeeded by a fever; which may obstruct the other excretions, as well as those of the breast.

In this case, the sudorifics above recommended must be prescribed; and if a plentiful sweat ensues, the patient will be relieved; at the same time the milk must be extracted from her breasts, by sucking with the mouth or glasses: should these methods fail, and the fever increase, she ought to be blooded in the arm; and instead of the external applications hitherto used, emollient liniments and cataplasms must be substituted, in order to soften and relax. If, in spite of these endeavours, the fever proceeds for some days, the patient is frequently relieved by critical sweats, a large discharge from the uterus, miliary eruptions, or loose stools mixed with milk, which is curdled in the intestines; but should none of these evacuations happen, and the inflammation continue with increasing violence, there is danger of an imposthume, which is to be brought to maturity, and managed like other inflammatory tumours; and no astringents ought to be applied, lest they should produce schirrhous swellings in the glands. Evacuations.

As the crisis of this fever, as well as of that last described, often consists in miliary eruptions over the whole surface of the body, but particularly on the neck and breast, by which the fever is carried off, nothing ought to be given which will either greatly increase or diminish the circulating force, but such only as will keep out the eruptions. But if, notwithstanding these eruptions, the fever, instead of abating, is augmented, it will be necessary to diminish its force, and prevent its increase, by those evacuations we have mentioned above. On the contrary, should the pulse sink, the eruptions begin to retreat inwardly, and the morbific matter be in danger of falling upon the viscera, we must endeavour to keep them out by opiates and sudorific medicines; and here blisters may be applied with success.

Chap. XXI. *Of the Evacuations necessary at the end of the Month after Delivery.*

Those who have had a sufficient discharge of the lochia, plenty of milk, and suckle their own children, commonly recover with ease, and, as the superfluous fluids of the body are drained off at the nipples, seldom require evacuations at the end of the month; but if there are any complaints from fullness, such as pains and stitches, after the 20th day, some blood ought to be taken from the arm, and the belly gently opened by frequent glysters, or repeated doses of laxative medicines.

If the patient has tolerably recovered, the milk having been at first sucked or discharged from the nipples, and afterwards discussed, no evacuations are necessary before the third or fourth week; and sometimes not till after the first flowing of the menses, which commonly happens about the fifth week; if they do not appear within that time, gentle evacuations must be prescribed, to carry off the plethora, and bring down the catamenia.

EXPLANATION of the PLATES.

Fig. 1. gives a front-view of the uterus *in situ* suspended in the vagina; the anterior parts of ossa ischium, with the ossa pubis; pudenda, perinæum, and anus, being removed in order to shew the internal parts. Plate CLXXVIII.

A, the last vertebra of the loins.

BB, the ossa ilium.

CC, the acetabula.

DD, the inferior and posterior parts of the ossa ischium.

E, the part covering the extremity of the coccyx.

F, the inferior part of the rectum.

GG, the vagina cut open longitudinally, and stretched on each side of the collum uteri, to shew in what manner the uterus is suspended in the same.

HH, part of the vesica urinaria stretched on each side of the vagina, and inferior part of the fundus uteri.

I, the collum uteri.

K, the fundus uteri.

LL, the tubi Fallopiani and fimbriæ.

MM, the ovaria.

NN, the

Explanat. of Plates.

NN, the ligamenta lata and rotunda.

OO, the fuperior part of the rectum.

Fig. 2. gives a front-view of the uterus in the beginning of the firft month of pregnancy; the anterior part being removed that the embryo might appear through the amnios, the chorion being diffected off.

A, the fundus uteri.

B, the collum uteri, with a view of the rugous canal that leads to the cavity of the fundus.

C, the os uteri.

Fig. 3. In the fame view and fection of the parts as in fig. 1. fhews the uterus as it appears in the fecond or third month of pregnancy.

F, the anus.

G, the vagina, with its plicæ.

HH, the pofterior and inferior part of the urinary bladder extended on each fide; the anterior and fuperior part being removed.

II, the mouth and neck of the womb, as raifed up when examining the fame by the touch, with one of the fingers in the vagina.

KK, the uterus as ftretched in the fecond or third month, containing the embryo, with the placenta adhering to the fundus.

Fig. 4. In the fame view and fection of the parts with the former figures, reprefents the uterus in the eighth or ninth month of pregnancy.

A, the uterus as ftretched to near its full extent, with the waters, and containing the fœtus entangled in the funis, the head prefenting at the upper part of the pelvis.

BB, the fuperior part of the offa ilium.

CC, the acetabula.

DD, the remaining pofterior parts of the offa ifchium.

E, the coccyx.

F, the inferior part of the rectum.

GGG, the vagina ftretched on each fide.

H, the os uteri, the neck being ftretched to its full extent or entirely obliterated.

II, part of the vefica urinaria.

KK, the placenta, at the fuperior and pofterior part of the uterus.

LL, the membranes.

M, the funis umbilicalis.

Fig. 5. gives a front view of twins *in utero* in the beginning of labour.

A, the uterus as ftretched, with the membranes and waters.

BB, the fuperior parts of the offa ilium.

CC, the acetabula.

DD, the offa ifchium.

E, the coccyx.

F, the lower part of the rectum.

GG, the vagina.

H, the os internum ftretched open about a finger-breadth, with the membranes and waters in time of labour-pains.

II, The inferior part of the uterus, ftretched with the waters which are below the head of the child that prefents.

KK, the two placentas adhering to the pofterior part of the uterus, the two fœtufes lying before them, one with its head in a proper pofition at the inferior part of the uterus, and the other fituated preternaturally with the head to the fundus: the bodies of each are here entangled in their proper funis, which frequently happens in the natural as well as preternatural pofitions.

LLL, the membranes belonging to each placenta.

Fig. 6. fhews, in a lateral view and longitudinal divifion of the parts, the gravid uterus when labour is fomewhat advanced.

A, the loweft vertebra of the back; the diftance from which to the laft-mentioned vertebra is here fhewn by dotted lines.

CC, the ufual thicknefs and figure of the uterus when extended by the waters at the latter end of pregnancy.

D, the fame contracted and grown thicker after the waters are evacuated.

EE, the figure of the uterus when pendulous.

FF, the figure of the uterus when ftretched higher than ufual, which generally occafions vomitings and difficulty of breathing.

G, the os pubis of the left fide.

HH, the os internum.

I, the vagina.

K, the left nympha.

L, the labium pudendi of the fame fide.

M, The remaining portion of the bladder.

N, the anus.

OP, the left hip and thigh.

Fig. 7. fhews the forehead of the fœtus turned backwards to the os facrum, and the occiput below the pubes, by which means the narrow part of the head is to the narrow part of the pelvis, that is, between the inferior parts of the offa ifchium.

A, the uterus contracted clofely to the fœtus after the waters are evacuated.

BCD, the vertebræ of the loins, os facrum, and coccyx.

E, the anus.

F, the left hip.

G, the perinæum.

H, the os externum beginning to dilate.

I, the os pubis of the left fide.

K, the remaining portion of the bladder.

L, the pofterior part of the os uteri.

Fig. 1. is principally intended to fhew in what manner the perinæum and external parts are ftretched by the head of the fœtus, in a firft pregnancy, towards the end of the labour. Plate CLXXIX.

A, the abdomen.

B, the labia pudendi.

C, the clitoris and its preputium.

D, the hairy fcalp of the fœtus, fwelled at the vertex, in a laborious cafe, and protruded to the os externum.

E, F, the perinæum and anus pufhed out by the head of the fœtus in form of a large tumour.

GG, the parts that cover the tuberofities of the offa ifchium.

H, the part that covers the os coccygis.

Fig. 2. fhews in what manner the head of the fœtus is helped along with the forceps, as artificial hands, when it is neceffary for the fafety of either mother or child.

AABC, the vertebræ of the loins, os facrum, and coccyx.

D, the

A. Bell Sculp.

Fig. 1.

Fig. 2.

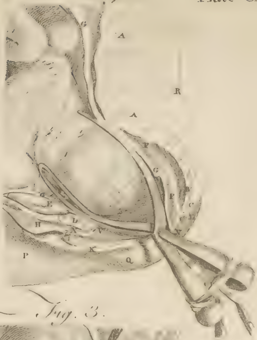


Fig. 4.

Fig. 3.

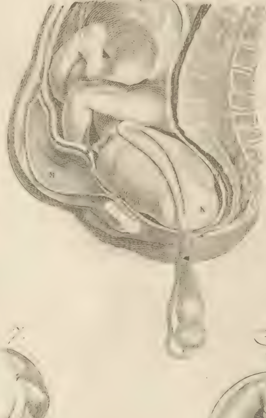


Fig. 7.

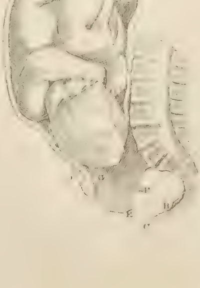


Fig. 6.

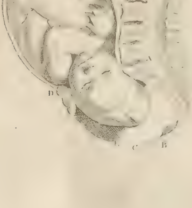


Fig. 5.

A. Bell Sculp.

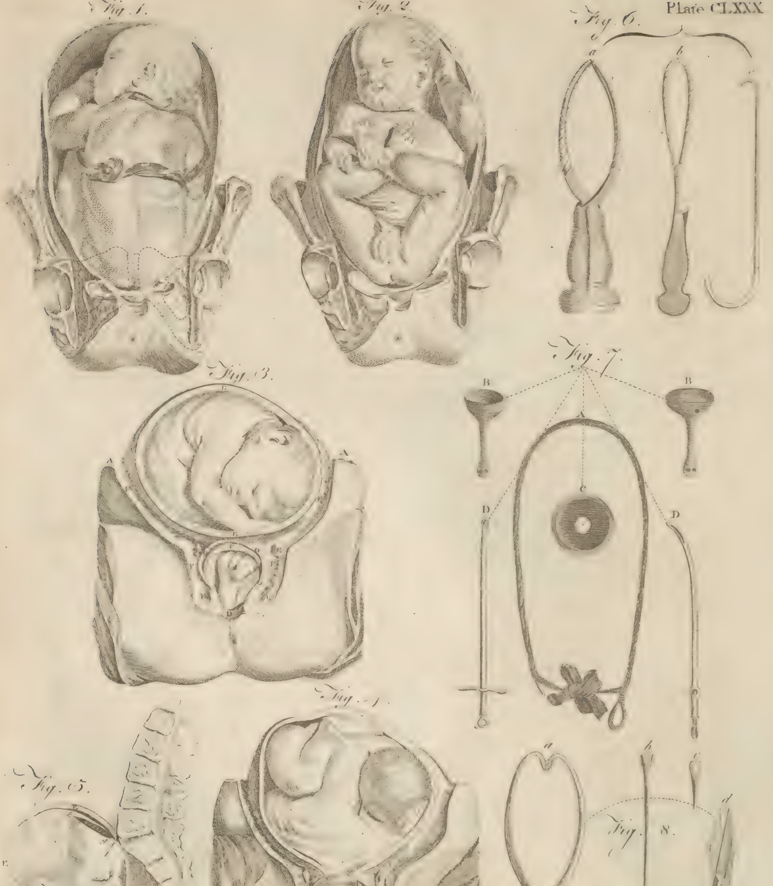


Fig. 1.
Fig. 2.
Fig. 6.
Fig. 3.
Fig. 7.
Fig. 4.
Fig. 5.
Fig. 8.
A. Bell. Sc.

Explanat. of Plates.

D, the os pubis of the left fide.

E, the remaining part of the bladder.

FF, the inteftinum rectum.

GGG, the uterus.

H, the mons veneris.

I, the clitoris, with the left nymph.

X, the corpus cavernofum clitoridis.

V, the meatus urinarius.

K, the left labium pudendi.

L, the anus.

N, the perinæum.

QP, the left hip and thigh.

R, the fkin and mufcular parts of the loins.

Fig. 3. fhews the head of the fœtus, by ftrong labour-pains, fqueezed into a longifh form, with a tumour on the vertex, from a long compreffion of the head in the pelvis.

K, the tumour on the vertex.

L, the forceps.

M, the vefica urinaria much diftended with a large quantity of urine from the long preffure of the head againft the urethra.

N, the under part of the uterus.

OO, the os uteri.

Fig. 4. fhews, in the lateral view, the face of the child prefenting and forced down into the lower part of the pelvis, the chin being below the pubes, and the vertex in the concavity of the os facrum: the water being likewife all difcharged, the uterus appears clofely joined to the body of the child.

Fig. 5. fhews, in a lateral view, the head of the child in the fame pofition as in the former figure.

AB, the vertebræ of the loins, os facrum, and coccyx.

C, the os pubis of the left fide.

D, the inferior part of the rectum.

E, the perinæum.

F, the left labium pudendi.

GGG, the uterus.

Fig. 6. gives a lateral internal view of a diftorted pelvis, divided longitudinally, with the head of a fœtus of the feventh month paffing the fame.

ABC, the os facrum and coccyx.

D, the os pubis of the left fide.

E, the tuberofity of the os ifchium of the fame fide.

Fig. 7. gives a fide-view of a diftorted pelvis, divided longitudinally, with the head of a full grown fœtus fqueezed into the brim, the parietal bones decuffating each other, and compreffed into a conical form.

ABC, the os facrum and coccyx.

D, the os pubis of the left fide.

E, the tuberofity of the os ifchium.

F, the proceffus acutus.

G, the foramen magnum.

Plate CLXXX. Fig. 1. fhews, in a front view of the pelvis, the breech of the fœtus prefenting, and dilating the os internum, the membranes being too foon broke.

Fig. 2. is the reverfe of fig. 1. the fore-parts of the child being to the fore-part of the uterus.

Fig. 3. reprefents, in a front-view of the pelvis, the fœtus compreffed, by the contraction of the uterus, into a round form, the fore-parts of the former being towards the inferior part of the latter, and one foot and hand fallen down into the vagina. In this figure, the anterior part of the pelvis is removed, by a longitudinal fection through the middle of the foramen magnum.

AA, the fuperior parts of the offa ilium.

BB, the uterus.

C, the mouth of the womb ftretched and appearing in

OOOO, the vagina.

D, the inferior and pofterior part of the os externum.

EEEE, the remaining parts of the offa pubis and ifchium.

FFFF, the membrana adipofa.

Fig. 4. reprefents, in the fame view with fig. 3. the fœtus in the contrary pofition; the breech and fore-parts being towards the fundus uteri, the left arm in the vagina, and the fore-arm without the os externum, the fhoulder being likewife forced into the os uteri.

Fig. 5. reprefents, in a lateral view of the pelvis, the method of extracting, by means of a curved crotchet, the head of the fœtus, when left in the uterus, after the body is delivered and feparated from it; either by its being too large, or the pelvis too narrow.

ABC, the os facrum and coccyx.

D, the os pubis of the left fide.

EE, the uterus.

F, the locking part of the crotchet.

g, h, i, the point of the crotchet on the infide of the cranium.

Fig. 6. reprefents the forceps and blunt-hook.

A, the ftreight forceps, in the exact proportion as to the width between the blades, and length from the points to the locking-part; the firft being two and the fecond fix inches, which, with three inches and a half, (the length of the handles), make in all eleven inches and a half.

B reprefents the pofterior part of a fingle blade in order to fhew the width and length of the open part of the fame, and the form and dimenfions of the whole.

C, the blunt hook, which is ufed for three purpofes: 1. To affift the extraction of the head, after the cranium is opened with the fciffars, by introducing the fmall end along the ear on the outfide of the head to above the under-jaw, where the point is to be fixed; the other extremity of the hook being held with one hand, whilft two fingers of the other are to be introduced into the forefaid opening, by which holds the head is to be gradually extracted. 2. The fmall end is ufeful in abortions, in any of the firft four or five mouths, to hook down the fecundines, when lying loofe in the uterus, when they cannot be extracted by the fingers or labour-pains, and when the patient is much weakened by floodings. 3. The large hook at the other end is ufeful to affift the extraction of the body, when the breech prefents; but fhould be ufed with great caution, to avoid the diflocation or fracture of the thigh.

Fig. 7. A reprefents the whale-bone fillet, which may be fometimes ufeful in laborious cafes, when the operator is not provided with the forceps, in fudden and unexpected exigencies.

BB, two views of a peffary for the prolapfus uteri. After the uterus is reduced, the large end of the peffary is to be introduced into the vagina, and the os uteri retained in the concave part, where there are three holes

Explanat. of Plates.

holes to prevent the ſtagnation of any moiſture. The ſmall end without the os externum has two tapes drawn through the two holes, which are tied to four other tapes, that hang down from a belt that ſurrounds the woman's body, and by this means keep up the peſſary. This peſſary may be taken out by the patient when ſhe goes to bed, and introduced again the morning; but as this ſometimes rubs the os externum, ſo as to make its uſe uneaſy, the round kind, marked C, are of more general uſe. They are made of wood, ivory, or cork, (the laſt covered with cloth and dipped in wax:) the peſſary is to be lubricated with pomatum, the edge forced through the paſſage into the vagina, and a finger introduced in the hole in the middle lays it acroſs within the os externum. They ought to be larger or ſmaller, according to the wideneſs or narrowneſs of the paſſage, to prevent their being forced out by any extraordinary ſtraining.

DD gives two views of a female catheter, to ſhew its degree of curvature and different parts.

Fig. 8. *a*, repreſents a pair of curved crotchets locked together in the ſame manner as the forceps. The dotted lines along the inſide of one of the blades repreſent a ſheath contrived to guard the point till it is introduced high enough: the ligature at the handles marked with two dotted lines is then to be untied, the ſheath withdrawn, and the point being uncovered is fixed as in fig. 5.

b, gives a view of the back-part of one of the crotchets, which is 12 inches long.

c, a front view of the point, to ſhow its proportional length and breadth.

d, the ſciſſars for perforating the cranium in very narrow and diſtorted pelviſes. They ought to be made very ſtrong, and at leaſt nine inches in length, with ſtops or reſts in the middle of the blades, by which a large dilatation is more eaſily made.

Migdol || Migration.

MIGDOL, or MAGDOL, (anc. geog.), a place in the Lower Egypt, on this ſide Pihahiroth, or between it and the Red-Sea, towards its extremity. The term denotes a tower or fortreſs. It is probably the *Magdolus* of Herodotus; ſeeing the Septuagint render it by the ſame name.

MIGNARD (Nicholas), a very ingenious French painter, born at Troyes in 1628; but, ſettling at Avignon, is generally diſtinguiſhed from his brother Peter by the appellation of *Mignard of Avignon*. He was afterwards employed at court and at Paris, where he became rector of the royal academy of painting. There are a great number of his hiſtorical pieces and portraits in the palace of the Tuilleries. He died in 1690.

MIGNARD (Peter), the brother of Nicholas, was born at Troyes in 1610; and acquired ſo much of the taſte of the Italian ſchool as to be known by the name of the *Roman*. He was generally allowed to have a ſuperior genius to his brother Nicholas; and had the honour of painting the popes Alexander VII. and Urban VIII. beſides many of the nobility at Rome, and divers of the Italian princes: his patron, Lewis, ſat ten times to him for his portrait, and reſpected his talents ſo much as to ennoble him, make him his principal painter after the death of Le Brun, and appoint him director of the manufactories. He died in 1695; and many of his pieces are to be ſeen at St Cloud.

MIGNON (Abraham), a celebrated painter, born at Francfort, acquired a great reputation by his ſkill in repreſenting flowers, fruits, inſects, flies, birds, and fiſhes. His colouring is admirable; and the dew ſpread on the flowers is ſo well imitated in his pictures, that one is tempted to take hold of them.

MIGRATION, the paſſage or removal of a thing out of one place into another.

MIGRATION *of Birds*.—It has been generally believed that many different kinds of birds annually paſs from one country to another, and ſpend the ſummer or the winter where it is moſt agreeable to them; and that even the birds of our own iſland will ſeek the moſt diſtant ſouthern regions of Africa, when directed by a peculiar inſtinct to leave their own country. It hath long been an opinion pretty generally received, that ſwallows reſide during the winter-ſeaſon in the warm ſouthern regions; and Mr Adanſon particularly relates his having ſeen them at Senegal when they were obliged to leave this country. But beſides the ſwallow, Mr Pennant enumerates many other birds which migrate from Britain at different times of the year, and are then to be ſound in other countries; after which they again leave theſe countries, and return to Britain. The reaſon of theſe migrations he ſuppoſes to be a defect of food at certain ſeaſons of the year, or the want of a ſecure aſylum from the perſecution of man during the time of courtſhip, incubation, and nutrition.—The following is his liſt of the migrating ſpecies.

Migration.

1. *Crows*. Of this genus, the hooded crow migrates regularly with the woodcock. It inhabits North Britain the whole year: a few are ſaid annually to breed on Dartmoor, in Devonſhire. It breeds alſo in Sweden and Auſtria: in ſome of the Swediſh provinces it only ſhifts its quarters, in others it reſides throughout the year. Our author is at a loſs for the ſummer retreat of thoſe which viſit us in ſuch numbers in winter, and quit our country in the ſpring; and for the reaſon why a bird, whoſe food is ſuch that it may be found at all ſeaſons in this country, ſhould leave us.

2. *Cuckoo*. Diſappears early in autumn; the retreat of this and the following bird is quite unknown to us.

3. *Wryneck*. Is a bird that leaves us in the winter. If its diet be ants alone, as ſeveral aſſert, the cauſe of its migration is very evident. This bird diſappears before winter, and reviſits us in the ſpring a little earlier than the cuckoo.

4. *Hoopoe*. Comes to England but by accident: Mr Pennant once indeed heard of a pair that attempted to make their neſt in a meadow at Selborne, Hampſhire, but were frighted away by the curioſity of people. It breeds in Germany.

5. *Grous*. The whole tribe, except the quail, lives here all the year round: that bird either leaves us, or elſe retires towards the ſea-coaſts.

6. *Pigeons*. Some few of the ring-doves breed here; but the multitude that appears in the winter, is ſo diſproportioned to what continue here the whole year, as to make it certain that the greateſt part quit the

the country in the fpring. It is moft probable they go to Sweden to breed, and return from thence in autumn; as Mr Ekmark informs us they entirely quit that country before winter. Multitudes of the common wild pigeons alfo make the northern retreat, and vifit us in winter; not but numbers breed in the high cliffs in all parts of this ifland. The turtle alfo probably leaves us in the winter, at leaft changes its place, removing to the fouthern counties.

7. *Stare.* Breeds here. Poffibly feveral remove to other countries for that purpofe, fince the produce of thofe that continue here feems unequal to the clouds of them that appear in winter. It is not unlikely that many migrate into Sweden, where Mr Berger obferves they return in fpring.

8. *Thrufhes.* The fieldfare and the redwing breed and pafs their fummers in Norway and other cold countries; their food is berries, which abounding in our kingdoms, tempts them here in the winter. Thefe two and the Royfton crow are the only land-birds that regularly and conftantly migrate into England, and do not breed here. The hawfinch and crofsbill come here at fuch uncertain times as not to deferve the name of *birds of paffage.*

9. *Chatterer.* The chatterer appears annually about Edinburgh in flocks during winter; and feeds on the berries of the mountain-afh. In South Britain it is an accidental vifitant.

10. *Grofbeaks.* The grofbeak and crofsbill come here but feldom; they breed in Auftria. The pine grofbeak probably breeds in the forefts of the Highlands of Scotland.

11. *Buntings.* All the genus inhabits England throughout the year; except the greater brambling, which is forced here from the north in very fevere feafons.

12. *Finches.* All continue in fome parts of thefe kingdoms, except the fifkin, which is an irregular vifitant, faid to come from Ruffia. The linnets fhift their quarters, breeding in one part of this ifland, and remove with their young to others. All finches feed on the feeds of plants.

13. *Larks, fly-catchers, wagtails, and warblers.* All of thefe feed on infects and worms; yet only part of them quit thefe kingdoms; though the reafon of migration is the fame to all. The nightingale, blackcap, fly-catcher, willow-wren, wheat-ear, and whitethroat, leave us before winter, while the fmall and delicate golden-crefted wren braves our fevereft frofts. The migrants of this genus continue longeft in Great Britain in the fouthern counties, the winter in thofe parts being later than in thofe of the north; Mr Stillingfleet having obferved feveral wheat-ears in the ifle of Purbeck on the 18th of November. As thefe birds are incapable of very diftant flights, Spain, or the fouth of France, is probaby their winter-afylum.

14. *Swallows and goat-fucker.* Every fpecies difappears at the approach of winter.

WATER-FOWL.

Of the vaft variety of water-fowl that frequent Great Britain, it is amazing to reflect how few are known to breed here: the caufe that principally urges them to leave this country, feems to be not merely the want of food, but the defire of a fecure retreat. Our country is too populous for birds fo fhy and timid as the bulk of thefe are: when great part of our ifland was a mere wafte, a tract of woods and fen; doubtlefs many fpecies of birds (which at this time migrate) remained in fecurity throughout the year. Egrets, a fpecies of heron, now fcarce known in this ifland, were in former times in prodigious plenty; and the crane, that has totally forfaken this country, bred familiarly in our marfhes: their place of incubation, as well as of all other cloven-footed water-fowl (the heron excepted) being on the ground, and expofed to every one: as rural œconomy increafed in this country, thefe animals were more and more difturbed; at length, by a feries of alarms, they were neceffitated to feek, during the fummer, fome lonely fafe habitation.

On the contrary, thofe that build or lay in the almoft inacceffible rocks that impend over the Britifh feas, breed there ftill in vaft numbers, having little to fear from the approach of mankind: the only difturbance they meet with in general being from the defperate attempts of fome few to get their eggs.

CLOVEN-FOOTED WATER-FOWL.

15. *Herons.* The white heron is an uncommon bird, and vifits us at uncertain feafons; the common kind and the bittern never leave us.

16. *Curlews.* The curlew breeds fometimes on our mountains; but, confidering the vaft flights that appear in winter, it is probable that the greater part retire to other countries: the whimbrel breeds on the Grampian hills, in the neighbourhood of Invercauld.

17. *Snipes.* The woodcock breeds in the moift woods of Sweden, and other cold countries. Some fnipes breed here, but the greateft part retire elfewhere; as do every other fpecies of this genus.

18. *Sandpipers.* The lapwing continues here the whole year; the ruff breeds here, but retires in winter; the redfhank and fandpiper breed in this country, and refide here. All the others abfent themfelves during fummer.

19. *Plovers and oyfter-catcher.* The long-legged plover and fanderling vifit us only in winter; the dottrel appears in fpring and in autumn; yet, what is very fingular, we do not find it breeds in South Britain. The oyfter-catcher lives with us the whole year. The Norfolk plover and fea-lark breed in England. The green plover breeds on the mountains of the north of England, and on the Grampian hills.

We muft here remark, that every fpecies of the genera of curlews, woodcocks, fandpipers, and plovers, that forfake us in the fpring, retire to Sweden, Poland, Pruffia, Norway, and Lapland, to breed: as foon as the young can fly, they return to us again, becaufe the frofts which fet in early in thofe countries totally deprive them of the means of fubfifting; as the drynefs and hardnefs of the ground, in general, during our fummer, prevent them from penetrating the earth with their bills, in fearch of worms, which are the natural food of thefe birds. Mr Ekmark fpeaks thus of the retreat of the whole tribe of cloven-footed water fowl out of his country (Sweden) at the approach of winter; and Mr Klein gives much the fame account of thofe of Poland and Pruffia.

20. *Rails and gallinules.* Every fpecies of thefe two genera continue with us the whole year; the land-rail excepted, which is not feen here in winter. It likewife continues in Ireland only during the fummer-months, when

Migration.

when they are very numerous, as Mr Smith tells us in the *Hiſtory of Waterford*, p. 336. Great numbers appear in Angleſea the latter end of May; it is ſuppoſed that they paſs over from Ireland, the paſſage between the two iſlands being but ſmall. As we have inſtances of theſe birds lighting on ſhips in the channel and the Bay of Biſcay, we may conjecture their winter-quarters to be in Spain.

FINNED-FOOTED WATER-BIRDS.

21. *Phalaropes*. Viſit us but ſeldom; their breeding place is Lapland, and other arctic regions.

22. *Grebes*. The great-creſted grebe, the black and white grebe, and little grebe, breed with us, and never migrate; the others viſit us accidentally, and breed in Lapland.

WEB-FOOTED BIRDS.

23. *Avoſet*. Breed near Foſsdike in Lincolnſhire; but quit their quarters in winter. They are then ſhot in different parts of the kingdom, which they viſit, not regularly, but accidentally.

24. *Auks and guillemots*. The great auk or pinguin ſometimes breeds in St Kilda. The auk, the guillemot, and puffin, inhabit moſt of the maritime cliffs of Great Britain, in amazing numbers, during ſummer. The black guillemot breeds in the Baſs Iſle, and in St Kilda, and ſometimes in Llandidno rocks. We are at a loſs for the breeding place of the other ſpecies; neither can we be very certain of the winter reſidence of any of them, excepting of the leſſer guillemot and black-billed auk, which, during winter, viſit in vaſt flocks the Frith of Forth.

25. *Divers*. Theſe chiefly breed in the lakes of Sweden and Lapland, and ſome in countries near the pole; but ſome of the red-throated divers, the northern and the imber, may breed in the north of Scotland and its iſles.

26. *Terns*. Every ſpecies breeds here; but leaves us in the winter.

27. *Petrels*. The fulmar breeds in the Iſle of St Kilda, and continues there the whole year, except September and part of October: the ſhearwater viſits the Iſle of Man in April; breeds there; and, leaving it in Auguſt or the beginning of September, diſperſes over all parts of the Atlantic ocean. The ſtormfinch is ſeen at all diſtances from land on the ſame vaſt watery tract; nor is ever found near the ſhore except by ſome very rare accident, unleſs in the breeding ſeaſon. Mr Pennant found it on ſome little rocky iſles, off the north of Skie. It alſo breeds in St Kilda. He alſo ſuſpects that it neſtles on the Blaſquet Iſles off Kerry, and that it is the gourder of Mr Smith.

28. *Merganſers*. This whole genus is mentioned among the birds that fill the Lapland lakes during ſummer. Mr Pennant has ſeen the young of the red-breaſted in the north of Scotland: a few of theſe, and perhaps of the gooſanders, may breed there.

29. *Ducks*. Of the numerous ſpecies that form this genus, we know of few that breed here. The ſwan and gooſe, the ſhield-duck, the eider-duck, a few ſhovelers, garganies, and teals, and a very ſmall portion of the wild ducks.

The reſt contribute to form that amazing multitude of water-fowl that annually repair from moſt parts of Europe to the woods and lakes of Lapland and other arctic regions, there to perform the functions of incubation and nutrition in full ſecurity. They and their young quit their retreat in September, and diſperſe themſelves over Europe. With us they make their appearance the beginning of October; circulate firſt round our ſhores; and, when compelled by ſevere froſt, betake themſelves to our lakes and rivers. Of the web-footed fowl there are ſome of hardier conſtitutions than others: theſe endure the ordinary winters of the more northern countries; but when the cold reigns there with more than common rigour, repair for ſhelter to theſe kingdoms: this regulates the appearance of ſome of the diver kind, as alſo of the wild ſwans, the ſwallow-tailed ſhield-duck, and the different ſorts of gooſeanders which then viſit our coaſts. Barentz found the barnacles with their neſts in great numbers in Nova Zembla. *Collect. Voy. Dutch Eaſt-India Company*, 8vo. 1703. p. 19. Cluſius, in his *Exot.* 368. alſo obſerves, that the Dutch diſcovered them on the rocks of that country and in Waygate Straits. They, as well as the other ſpecies of wild-geeſe, go very far north to breed, as appears from the hiſtories of Greenland and Spitzbergen, by Egede and Crantz. Theſe birds ſeem to make Iceland a reſting place, as Horrebow obſerves: few continue there to breed, but only viſit that iſland in the ſpring, and after a ſhort ſtay retire ſtill further north.

30. *Corvorants*. The corvorant and ſhag breed on moſt of our high rocks: the gannet in ſome of the Scotch iſles, and on the coaſt of Kerry: the two firſt continue on our ſhores the whole year. The gannet diſperſes itſelf all round the ſeas of Great Britain, in purſuit of the herring and pilchard, and even as far as the Tagus to prey on the ſardina.

But of the numerous ſpecies of fowl here enumerated, it may be obſerved how very few entruſt themſelves to us in the breeding ſeaſon, and what a diſtant flight they make to perform the firſt great dictate of nature.

There ſeems to be ſcarcely any but what we have traced to Lapland, a country of lakes, rivers, ſwamps, and alps, covered with thick and gloomy foreſts, that afford ſhelter during ſummer to theſe fowls, which in winter diſperſe over the greateſt part of Europe. In thoſe arctic regions, by reaſon of the thickneſs of the woods, the ground remains moiſt and penetrable to the woodcocks, and other ſlender-billed fowl: and for the web-footed birds, the waters afford larvæ innumerable of the tormenting knat. The days there are long; and the beautiful meteorous nights indulge them with every opportunity of collecting ſo minute a food: whilſt mankind is very ſparingly ſcattered over that vaſt northern waſte.

Why then ſhould Linnæus, the great explorer of theſe rude deſarts, be amazed at the myriads of water-fowl that migrated with him out of Lapland? which exceeded in multitude the army of Xerxes; covering, for eight whole days and nights, the ſurface of the river Calix. His partial obſervation as a botaniſt, would confine their food to the vegetable kingdom, almoſt denied to the Lapland waters; inattentive to a more plenteous table of inſect-food, which the all-bountiful Creator had ſpread for them in the wilderneſs. It may be remarked, that the lakes of mountainous rocky countries in general are deſtitute of plants: few or none are ſeen on thoſe of Switzerland; and Linnæus

makes

makes the ſame obſervation in reſpect to thoſe of Lapland; having, during his whole tour, diſcovered only a ſingle ſpecimen of a *lemna triſulca*, or "ivy-leaved duck's meat," *Flora Lap.* n° 470.; a few of the *ſcirpus lacuſtris*, or "bullruſh," n° 18.; the *alopecurus geniculatus*, or "flote foxtail graſs," n° 38.; and the *ranunculus aquatilis*, n° 234.; which are all he enumerates in his *Prolegomena* to that excellent performance.

Under the article HIRUNDO, we have given the principal arguments for and againſt the migration of ſwallows. Here we ſhall give a ſhort abſtract of the arguments uſed by the Hon. Daines Barrington againſt the migration of birds in general, from a paper publiſhed by him in the 62d volume of the Philoſophical Tranſactions. This gentleman denies, that any well-atteſted inſtances can be produced of this ſuppoſed migration, which, if there were any ſuch periodical flight, could not poſſibly have eſcaped the frequent obſervation of ſeamen. It has indeed been aſſerted that birds of paſſage become inviſible in their flight, becauſe they riſe too high into the air to be perceived, and becauſe they chooſe the night for their paſſage. The author, however, expreſſes his doubts "whether any bird was ever ſeen to riſe to a greater height than perhaps twice that of St Paul's croſs;" and he further endeavours to ſhew, that the extent of ſome of theſe ſuppoſed migrations (from the northern parts of Europe, for inſtance, to the line) is too great to be accounted for, by having recourſe to the argument founded on a nocturnal paſſage.

The author next recites, in a chronological order, all the inſtances that he has been able to collect, of birds having been actually ſeen by mariners when they were croſſing a large extent of ſea; and he endeavours to ſhew that no ſtreſs can be laid on the few caſual obſervations of this kind that have been produced in ſupport of the doctrine of a regular and periodical migration.

Mr Barrington afterwards proceeds to invalidate M. Adanſon's celebrated obſervation with reſpect to the migration of the ſwallow in particular, and which has been conſidered by many as perfectly deciſive of the preſent queſtion. He endeavours to ſhew that the four ſwallows which that naturaliſt caught, on their ſettling upon his ſhip, on the 6th of October at about the diſtance of 50 leagues from the coaſt of Senegal, and which he ſuppoſes to have been then proceeding from Europe to paſs the winter in Africa, could not be true European ſwallows; or, if they were, could not have been on their return from Europe to Africa. His objections are founded principally on ſome proofs which he produces of M. Adanſon's want of accuracy on this ſubject, which has led him, in the preſent inſtance, to miſtake two African ſpecies of the ſwallow-tribe, deſcribed and engraved by Briſſon, for European ſwallows, to which they bear a general reſemblance: or granting even that they were European ſwallows, he contends, that they were flitting from the Cape de Verd Iſlands to the coaſt of Africa; "to which ſhort flight, however, they were unequal, and accordingly fell into the ſailor's hands."

After many obſervations and reflections on the ſubject, the author endeavours to ſupport the opinion that ſwallows, and perhaps ſome other ſuppoſed birds of paſſage, remain with us during the winter in a torpid ſtate; obſerving that, notwithſtanding the great care which they take to conceal themſelves, it is certain that they have been frequently found, during the period of their ſuppoſed abſence, lying hid in caverns, or hollow trees, and even under water. Beſides other inſtances, well known to thoſe who have attended to this ſubject, the author gives us the teſtimony of Mr Stephens A. S. S. who aſſured him that he had himſelf picked up a cluſter of three or four ſwallows (or martins) out of a pond of his father's at Shrivenham in Berkſhire, in the month of February; that they were caked together in the mud; and that, on carrying them into the kitchen, they ſoon flew about the room, in the preſence of his father, mother, and others. The ſame fact was afterwards confirmed to the author by Dr Pye, who was then Mr Stephens's ſchool-fellow at Shrivenham, and by another gentleman who now lives in that village.

It may naturally be aſked, why ſwallows, in particular, are not frequently thus found in their torpid ſtate. In anſwer to this queſtion the author obſerves, that the ſame inſtinct which prompts the bird thus to conceal itſelf, inſtructs it to chooſe ſuch a place of ſecurity, that common accidents will not diſcover it;—that ponds are ſeldom cleaned in the winter, as it is ſuch cold work for the labourers;—that facts of this ſort are little attended to; and that the common labourers who have the beſt chance of finding torpid birds, make no mention of the diſcovery to others, as they conſider it as a thing of courſe, and conſequently not intereſting to any one. He adds, that ſwallows may be conſtantly taken in the month of October, and even ſo late as November, during the dark night, while they ſit on the willows in the Thames; and that one may almoſt inſtantaneouſly fill a large ſack with them, becauſe at this time they will not ſtir from the twigs when you lay your hands upon them. This, ſays the author, looks very much like their beginning to be torpid, before they hide themſelves under the water.

To this argument, however, the monthly reviewers oppoſe the following, which appears to them deciſive in favour of migration. The ſwallow, it is ſuppoſed, like other birds, moults once a-year at leaſt: but during the whole time this bird is ſeen with us, it appears in full feather. The proceſs of moulting, therefore, muſt be performed ſomewhere: but as it is abſurd to ſuppoſe that this great change can be effected in theſe birds while they are lying aſleep, or torpid in caverns and hollow-trees, or immerſed in cluſters in the mud at the bottom of ponds or rivers, they muſt moult in ſome diſtant country, to which they retire when they diſappear in theſe parts.

MIGRATION *of Fiſhes*. See CLUPEA.

St MIGUEL, one of the Azore iſlands, ſituated in W. Long. 22. 45, N. Lat. 38. 10. This iſland appears to be entirely volcanic. The beſt account we have of it hath been publiſhed in the 68th volume of the Philoſophical Tranſactions by Mr Francis Maſſon. Acording to him, the productions differ greatly from thoſe of Madeira, inſomuch that none of the trees of the latter are found here, except the faya: it has a nearer affinity to Europe than Africa. The mountains are covered with the erica vulgaris, and an elegant

elegant ever-green ſhrub very like a phillyrea, which gives them a moſt beautiful appearance.

It is one of the principal and moſt fertile of the Azorian iſlands, lying nearly eaſt and weſt; its length is about 18 or 20 leagues; its breadth unequal, not exceeding five leagues, and in ſome places not more than two. It contains about 80000 inhabitants.

Its capital, the city of Ponta del Guda, which contains about 12000 inhabitants, is ſituated on the ſouth ſide of the iſland, on a fine fertile, plain country, pretty regularly built; the ſtreets ſtraight, and of a good breadth. It is ſupplied with good water, which is brought about the diſtance of three leagues from the neighbouring mountains. The churches and other religious edifices are elegant and well built for ſuch an iſland. There is a large convent of Franciſcan friars and one of the order of St Auguſtin, four convents for profeſſed nuns, and three Recolhimentos for young women and widows who are not profeſſed. The veſſels anchor in an open road; but it is not dangerous, as no wind can prevent their going to ſea in caſe of ſtormy weather.

The country round the city is plain for ſeveral miles, well cultivated, and laid out with good taſte into ſpacious fields, which are ſown with wheat, barley, Indian corn, pulſe, &c. and commonly produce annually two crops; for as ſoon as one is taken off, another is immediately ſown in its place. The ſoil is remarkably gentle and eaſy to work, being for the moſt part compoſed of pulverized pumice-ſtone. There are in the plains a number of pleaſant country-ſeats, with orchards of orange trees, which are eſteemed the beſt in Europe.

The ſecond town is Ribeira Grande, ſituated on the north ſide of the iſland, containing about as many inhabitants as the city; a large convent of Franciſcan friars, and one of nuns. It gives title to a count, called the *Conde Ribeira Grande*, who firſt inſtituted linen and woollen manufactories in the iſland.

The third town is Villa Franca, on the ſouth ſide of the iſland, about ſix leagues eaſt of Ponta del Guda. It has a convent of Franciſcan friars, and one of nuns, which contains about 300. Here, about half a mile from the ſhore, lies a ſmall iſland (Ilhao), which is hollow in the middle, and contains a fine baſon with only one entrance into it, fit to hold fifty ſail of veſſels ſecure from all weather; at preſent it wants cleaning out, as the winter's rain waſhes down great quantities of earth into it, which has greatly diminiſhed its depth. But veſſels frequently anchor between this iſland and the main.

Beſide theſe towns are ſeveral ſmaller, viz. Alagoa, Agoa de Pao, Brelanha, Fanaes de Ajuda, and a number of hamlets, called *lugars*, or *places*.

About four leagues north-eaſt from Villa Franca, lies a place called the *Furnas*, being a round deep valley in the middle of the eaſt part of the iſland, ſurrounded with high mountains, which, though ſteep, may be eaſily aſcended on horſeback by two roads. The valley is about five or ſix leagues in circuit. The face of the mountains, which are very ſteep, is entirely covered with beautiful ever-greens, viz. myrtles, laurels, a large ſpecies of bilberry called *uva de ſerra*, &c. and numberleſs rivulets of the pureſt water run down their ſides. The valley below is well cultivated, producing wheat, Indian corn, flax, &c. The fields are planted round with a beautiful ſort of poplars, which grow into pyramidal forms, and by their careleſs, irregular diſpoſition, together with the multitude of rivulets, which run in all directions through the valley, a number of boiling fountains throwing up clouds of ſteam, a fine lake in the ſouth-weſt part about two leagues round, compoſe a proſpect the fineſt that can be imagined. In the bottom of the valley the roads are ſmooth and eaſy, there being no rocks but a fine pulverized pumice-ſtone that the earth is compoſed of.

There are a number of hot fountains in different parts of the valley, and alſo on the ſides of the mountains: but the moſt remarkable is that called the *chaldeira*, ſituated on the eaſtern part of the valley, on a ſmall eminence by the ſide of a river, on which is a baſon about 30 feet diameter, where the water continually boils with prodigious fury. A few yards diſtant from it is a cavern in the ſide of the bank, in which the water boils in a dreadful manner, throwing out a thick, muddy, unctuous water ſeveral yards from its mouth with a hideous noiſe. In the middle of the river are ſeveral places where the water boils up ſo hot, that a perſon cannot dip his finger into it without being ſcalded; alſo along its banks are ſeveral apertures, out of which the ſteam riſes to a conſiderable height, ſo hot that there is no approaching it with one's hand: in other places, a perſon would think that 100 ſmiths bellows were blowing all together, and ſulphureous ſteams iſſuing out in thouſands of places; ſo that native ſulphur is found in every chink, and the ground covered with it like hoar-froſt; even the buſhes that happen to lie near theſe places are covered with pure brimſtone, condenſing from the ſteam that iſſues out of the ground, which in many places is covered over with a ſubſtance like burnt alum. In theſe ſmall caverns, where the ſteam iſſues out, the people often boil their yams.

Near theſe boiling fountains are ſeveral mineral ſprings; two in particular, whoſe waters have a very ſtrong mineral quality, of an acid taſte, and bitter to the tongue.

About half a mile to the weſtward, and cloſe by the river ſide, are ſeveral hot ſprings, which are uſed by ſick people with great ſucceſs. Alſo, on the ſide of a hill weſt of St Ann's church, are many others, with three bathing-houſes, which are moſt commonly uſed. Theſe waters are very warm, altho' not boiling hot; but at the ſame place iſſue ſeveral ſtreams of cold mineral water, by which they are tempered, according to every one's liking.

About a mile ſouth of this place, and over a low ridge of hills, lies a fine lake about two leagues in circumference, and very deep, the water thick, and of a greeniſh colour. At the north end is a plain piece of ground, where the ſulphureous ſteams iſſue out in many places, attended with a ſupriſing blowing noiſe. Our author could obſerve ſtrong ſprings in the lake, but could not determine whether they were hot or cold: this lake ſeems to have no viſible evacuation. The other ſprings immediately form a conſiderable river, called *Ribeira Quente*, which runs a courſe about two or three leagues, thro' a deep rent in the mountains, on each ſide of which are ſeveral places where the ſmoke iſſues

 iſſues out. It diſcharges itſelf into the ſea on the ſouth ſide, near which are ſome places where the water boils up at ſome diſtance in the ſea.

This wonderful place had been taken little notice of until very lately; ſo little curioſity had the gentlemen of the iſland, that ſcarcely any of them had ſeen it, until of late ſome perſons, afflicted with very virulent diſorders, were perſuaded to try its waters, and found immediate relief from them. Since that time it has become more and more frequented; ſeveral perſons who had loſt the uſe of their limbs by the dead palſy have been cured; and alſo others who were troubled with eruptions on their bodies.

A clergyman, who was greatly afflicted with the gout, tried the ſaid waters, and was in a ſhort time perfectly cured, and has had no return of it ſince. When Mr Maſſon was there, ſeveral old gentlemen, who were quite worn out with the ſaid diſorder, were uſing the waters, and had received incredible benefit from them; in particular, an old gentleman, about 60 years of age, who had been tormented with that diſorder more than 20 years, and often confined to his bed for ſix months together: he had uſed theſe waters about three weeks, had quite recovered the uſe of his limbs, and walked about in the greateſt ſpirits imaginable. A friar alſo who had been troubled with the ſaid diſorder about 12 years, and reduced to a cripple, by uſing them a ſhort time was quite well, and went a-hunting every day,

There are ſeveral other hot ſprings in the iſland, particularly at Ribeira Grande; but they do not poſſeſs the ſame virtues, at leaſt not in ſo great a degree.

The eaſt and weſt part of the iſland riſes into high mountains; but the middle is low, interſperſed with round conic hills, all of which have very recent marks of fire; all the parts below the ſurface conſiſting of melted lava lying very hollow.

Moſt of the mountains to the weſtward have their tops hollowed out like a punch-bowl, and contain water. Near the weſt end is an immenſe deep valley, like the Furnas called the *Sete Cidades*. This valley is ſurrounded with very abrupt mountains, about ſeven or eight leagues round; in the bottom is a deep lake of water, about three leagues in circuit, furniſhed with great number of water-fowls. This water has no mineral quality; neither are there any hot ſprings in the valley. All theſe mountains are compoſed of a white crumbly pumice-ſtone, which is ſo looſe, that, if a perſon thruſt a ſtick into the banks, whole waggon-loads of it will tumble down. The inhabitants of the iſland relate a ſtory, that he who firſt diſcovered it obſerved an extraordinary high peak near the weſt end; but the ſecond time he viſited it, no ſuch peak was to be ſeen, which he ſuppoſed muſt have certainly ſunk;—but, however improbable this ſtory may be, at ſome period or another it muſt have certainly been the caſe.

MILAN, or the duchy of the Milaneſe, a country of Italy, bounded on the weſt by Savoy, Piedmont, and Montferrat; by Switzerland on the north; by the territories of Venice, the duchies of Mantua, Parma, and Placentia, on the eaſt; and by the territories of Genoa on the ſouth. Anciently this duchy, containing the north part of the Old Liguria, was called *Inſubria*, from its inhabitants the *Inſubres*; who were conquered by the Romans, as theſe were by the Goths; who in their turn were ſubdued by the Lombards. Didier, the laſt king of the Lombards, was taken priſoner by Charlemagne, who put an end to the Longobardic empire, and appointed governors of Milan. Theſe governors, being at a diſtance from their maſters, ſoon began to aſſume an independency, which brought a dreadful calamity on the country; for, in 1152, the capital itſelf was levelled with the ground by the emperor Frederic Barbaroſſa, who committed great devaſtations otherwiſe throughout the duchy. Under this emperor lived one Galvian, a nobleman who was deſcended from Otho a Milaneſe. Galvian, along with William prince of Montferrat, ſerved in the cruſade, when Godfrey of Boulogne took Jeruſalem: he killed in ſingle combat the Saracen general, whom he ſtripped of his helmet, which was adorned with the image of a ſerpent ſwallowing a youth; and this ever afterwards was the badge of that family. His grandſon Galvian, having oppoſed the emperor, was taken priſoner, and carried in irons into Germany, from whence he made his eſcape, and returning to Milan, died in the ſervice of his country. From him deſcended another Otho, at the time that Otho IV. was emperor of Germany, and who ſoon diſtinguiſhed himſelf by the accompliſhments both of his mind and body. When he grew up, he was received into the family of cardinal Octavian Ubaldini at Rome. This prelate, who was himſelf aſpiring at the popedom, was in a ſhort time greatly taken with the addreſs and accompliſhments of young Otho, and predicted his future greatneſs. In the mean time, one Torreſs, or Torriano, a Milaneſe nobleman of unbounded ambition, was attempting to make himſelf maſter of Milan. The popular faction had ſome time before been caballing againſt the nobility; and at laſt, Torriano, putting himſelf at their head, expelled the biſhop, and put to death or baniſhed all the nobility: by which means the popular government was fully eſtabliſhed; and Torriano, under this pretence, ruled every thing as he pleaſed. He was, however, ſoon oppoſed by one Franciſco Sepri, who formed a great party, pretending to deliver the city from Torriano's haughtineſs and cruelty. But while the two parties were collecting their forces againſt each other, cardinal Ubaldini was projecting the deſtruction of both, by means of his favourite Otho. This prelate had for ſome time borne an implacable hatred to Torriano, becauſe he had been by him prevented from carrying out of the treaſury of St Ambroſe's church at Milan, a carbuncle or jewel of great value, which he pretended to reſerve for adorning the papal tiara; for which reaſon he now determined to oppoſe his ambition.

Ubaldini began with naming Otho archbiſhop of Milan; which, as the pope's legate, he had a right to do. This nomination was confirmed by Pope Urban IV.; and the party of the nobility having now got a head from the pope himſelf, began to gather ſtrength. Otho in the mean time employed himſelf in collecting troops; and had no ſooner procured a ſhew of an army, than he advanced towards Lago Maggione, and took poſſeſſion of Arona, a ſtrong poſt near that lake: but Torriano, marching immediately

againſt him with all his troops, obliged him to abandon the place, and leave his party to make the beſt terms they could with the conqueror. This was followed by the deſtruction of the caſtles of Arona, Anghiari, and Brebia: ſoon after which Torriano died; and was ſucceeded by his brother Philip, who had ſufficient intereſt to get himſelf elected podeſta, or prætor of Milan, for ten years. During his lifetime, however, the party of the nobility increaſed conſiderably under Otho, notwithſtanding the check they had received. Philip died in 1265, having loſt ground conſiderably in the affections of the people, though he obtained a great reputation for his courage and conduct. His ſucceſſor Napi rendered himſelf terrible to the nobility, whom he proſcribed, and put to death as often as he could get them into his power. He proceeded ſuch lengths, and acted with ſuch fury againſt that unfortunate party, that pope Clement IV. who had ſucceeded Urban, at laſt interdicted Milan, and excommunicated Napi and all his party. By this Napi began to loſe his popularity, and the public diſaffection towards him was much heightened by the natural cruelty of his temper. But in the mean time, the party of the nobility was in the utmoſt diſtreſs. Otho himſelf and his friends, having ſpent all their ſubſtance, wandered about from place to place; the pope not being in a capacity of giving them any aſſiſtance. Otho, however, was not diſcouraged by his bad ſucceſs, but found means ſtill to keep up the ſpirits of his party, who now choſe for their general Squarcini Burri, a man of great eminence and courage, whoſe daughter was married to Matthew Viſconti, afterwards called *Matthew the Great*. At the ſame time they renewed their confederacy with the marquis of Montferrat, who was ſon-in-law to the king of Spain. The marquis agreed to this confederacy chiefly with a view to become maſter of the Milaneſe.

The nobility now again began to make head; and having collected an army, which was joined by 600 Spaniſh cavalry and a body of foot, gained ſome advantages. But in the mean time Napi, having gathered together a ſuperior army, ſuddenly attacked Otho and Burri, and defeated them. After this diſaſter Otho applied to the pope; from whom, however, he did not obtain the aſſiſtance he deſired; and in the mean time Napi invited the emperor Rodolph into Italy, with the promiſe of being crowned at Milan. This invitation was accepted of with great readineſs by Rodolph; who conſtituted Napi his governor and vicar-general in Lombardy, ſending to him at the ſame time a fine body of German horſe, the command of which was given to Caſſoni, Napi's nephew. On this Otho again applied to the pope, (Gregory X.): but he was ſo far from granting him any aſſiſtance, that he is ſaid to have entered into a ſcheme of aſſaſſinating him privately; but Otho eſcaped the danger, and in 1276 began to recover his affairs. The reaſon of pope Gregory's enmity to him was, that he and his party were thought to be Gibelines, and were oppoſed by great numbers of the nobility themſelves; but after that pope's death, the Milaneſe exiles being united under one head, ſoon became formidable. They now choſe for their general Godfrey count of Languſio, a noble Pavian, and an inveterate enemy of the Torriano family. This nobleman being rich and powerful, enliſted many German and other mercenaries, at whoſe head he marched towards the Lago Maggiore. All the towns in that country opened their gates to him through the intereſt of the Viſconti family, who reſided in theſe parts. But this ſucceſs ſoon met with a ſevere check in an unfortunate engagement, wherein Godfrey was defeated and taken priſoner; after which he and 34 nobles had their heads ſtruck off, and ſent from the field of battle piled up in a common waggon.

This defeat greatly affected Otho; but having in a ſhort time recovered himſelf, he again attacked his enemies, and defeated them; but, ſuffering his troops to grow remiſs after their victory, the fugitives rallied, and entirely defeated him. The next year, however, Otho had better ſucceſs, and totally defeated and took priſoner Napi himſelf. After this victory Caſſoni was obliged to abandon Milan to his competitor, who kept poſſeſſion of it till his death, which happened in 1295, in the 87th year of his age.

Otho was ſucceeded by Matthew Viſconti abovementioned; and Milan continued in ſubjection to that family without any very memorable occurrence, till the year 1378, when, by the death of Galeazzo II. his brother Barnabo became ſovereign of Milan. He was of a brave and active diſpoſition; but exceſſively profuſe in his expences, as his brother Galeazzo had alſo been; and, to procure money to ſupply his extravagancies, was obliged to oppreſs his ſubjects. Galeazzo had engaged in an enterpriſe againſt Bologna, and the ſiege of it was continued by Barnabo. It laſted for nine years, and during this time is ſaid to have coſt 300 millions of gold, a prodigious ſum in thoſe days, near 40 millions ſterling; the loweſt gold coin being in value ſomewhat more than half-a-crown Engliſh. Both the brothers were exceſſively fond of building. Barnabo erected a bridge over the Adda, conſiſting of three ſtories, the loweſt for chariots and heavy carriages, the middle for horſes; and the uppermoſt for foot-paſſengers. He built alſo another bridge which was carried over houſes without touching them. To accompliſh theſe, and many other expenſive ſchemes, he became one of the greateſt tyrants imaginable, and every day produced freſh inſtances of his rapacity and cruelty. He inſtituted a chamber of inquiry, for puniſhing all thoſe who had for five years before been guilty of killing boars, or even of eating them at the table of another. They who could not redeem themſelves by money were hanged, and above 100 wretches periſhed in that manner. Thoſe who had any thing to loſe were ſtripped of all their ſubſtance, and obliged to labour at the fortifications and other public works. He obliged his ſubjects to maintain a great many hunting-dogs, and each diſtrict was taxed a certain number. The overſeers of his dogs were at the ſame time the inſtruments of his rapacity. When the dogs were poor and ſlender, the owners were always fined; but when the dogs were fat, the owners were alſo fined, for ſuffering them to live without exerciſe.

The extravagant behaviour of Barnabo ſoon rendered public affairs ready for a revolution, which was at laſt accompliſhed by his nephew John Galeazzo. He affected a ſolitary life, void of ambition, and even incling to devotion; but at the ſame time took care to have his uncle's court filled with ſpies, who gave

him

Milan. him information of all that paffed. He reduced his table and manner of living, pretending that he took thefe fteps as preparatives to a retirement from the world, which was foon to take place, after he had paid a religious vow. In fhort, he acted his part fo well, that even Barnabo, though abundantly cautious, had no fufpicion of his having any defigns againft him; and fo entirely did he conceal his ambition, that he feveral times made application to his uncle for his intereft to procure him a quiet retreat as foon as his religious vows were performed. One of thefe was to pay a vifit to the church of the bleffed Virgin upon mount Varezzio. This was to be done with fo much fecrecy that all kinds of eye-witneffes were to be excluded; and it was with difficulty that Barnabo himfelf and two of his fons were allowed to accompany our devotee. But, in the mean time, the hypocritical Galeazzo had foldiers advancing from all quarters, fo that Barnabo and his fons were immediately feized, and the houfes of thofe who had fided with them given up to be plundered. The booty in plate, money, and all kinds of rich furniture, was immenfe. The minifters of the late government were dragged from their hiding-places, and put to death; and at laft the citadel itfelf fell into the hands of Galeazzo, who found in it an immenfe fum of money. Barnabo was carried prifoner to Tritici, a caftle of his own building, where he had the happinefs to find one perfon ftill faithful to him. This was his miftrefs, named *Doninia Porra;* who, when he was abandoned by all the world, fhut herfelf up a voluntary prifoner in his chamber, and remained with him as long as he lived, which was only feven months after his degradation.

John Galeazzo was the firft who took upon him the title of the *duke of Milan*, and was a prince of great policy and no lefs ambition. He made war with the Florentines, became mafter of Pifa and Bologna, and entirely defeated the emperor in 1401, fo that he entertained hopes of becoming mafter of all Lombardy, and cutting off all poffibility of invading it either from France or Germany; but his defigns were fruftrated by death, which happened in 1402, in the 55th year of his age. After his deceafe the Milanefe government fell into the moft violent diftractions, fo that it could not be fupported, even in time of peace, without an army of 20,000 foot and as many horfe. In the year 1421, however, Philip duke of Milan became mafter of Genoa; but though he gained great advantages in all parts of Italy, the different ftates ftill found means to counterbalance his fucceffes, and prevent him from enflaving them: fo that Milan never became the capital of any extenfive empire; and in 1437 Genoa revolted, and was never afterwards reduced.

Philip died in 1448, and by his death the male line of the Vifconti family was at an end. The next lawful heir was Valentina his fifter, who had married the duke of Orleans fon to Charles V. of France. By the contract of that marriage, the lawful progeny of it was to fucceed to the duchy of Milan in failure of the heirs-male of the Vifconti family; but this fucceffion was difputed by Sforza, who had married Philip's natural daughter. It is certain, however, that the rightful fucceffion was vefted in the houfe of Orleans and the kings of France; and therefore though the Sforza family got poffeffion of the duchy for the prefent, Lewis XII. afterwards put in his claim, as being grandfon to John Galeazzo. For fome time he was fuccefsful; but the French behaved in fuch an infolent manner, that they were driven out of the Milanefe by the Swifs and Maximilian Sforza. The Swifs and Milanefe were in their turn expelled by Francis I. who obliged the Sforza family to relinquifh the government for a penfion of 30,000 ducats a-year. Francis Sforza, the fon of Maximilian, however, being affifted by the emperor and the pope, regained the poffeffion of the Milanefe about the year 1521; and, eight years after, the French king, by the treaty of Cambray, gave up his claim on the duchy. Milan.

But, in fact, the emperors of Germany feem to have had the faireft title to the Milanefe in right of their being for a long time fovereigns of Italy. On the death of Francis Sforza, therefore, in the year 1536, the emperor Charles V. declared the Milanefe to be an imperial fief, and granted the inveftiture of it to his fon Philip II. king of Spain. In his family it continued till the year 1706, when the French and Spaniards were driven out by the imperialifts, and the emperor again took poffeffion of it as a fief. It was confirmed to his houfe by the treaty of Baden in 1714, by the quadruple alliance in 1718, and by the treaty of Aix la Chapelle in 1748.

The duchy of Milan is one of the fineft provinces in Italy. It is bounded on the fouth by the Appenine mountains, and the territory of Genoa; on the north by Switzerland; on the eaft by the Venetian territories, and the duchies of Mantua, Parma, and Placentia; and on the weft by Savoy, Piedmont, and Montferrat; extending from north to fouth about 100 miles, and from eaft to weft about 108. It is well watered by the Teffino, the Sefia, the Adda, the Po, the Oglio, the Lombro, Serio, &c. and alfo by feveral canals and lakes. Of the latter the Lago Maggiore is between 30 and 40 miles in length, and in fome places fix or feven miles broad. In it lie the *Boromean iflands*, as they are called, viz. Ifola Bella and Ifola Madre, the beauty of which almoft exceeds imagination: art and nature feem to have vied with one another in embellifhing them. In each of them is a palace with delicious gardens, belonging to the Boromean family. The water of the lake is clear and of a greenifh colour, and abounds with fifh. The hills with which it is furrounded prefent a moft charming landfcape, being planted with vines and chefnut-trees, interfperfed with fummer-houfes. There is a canal running from it towards Switzerland, with which the city of Milan has a communication. It was anciently called *Lacus Verbanus*. The Lago de Como, which was called by the Latin poets *Lacus Larius*, but had its modern name from the city, near which it lies, extends itfelf about 30 miles northward from Como, but its greateft breadth is not above five miles. From the Lago Maggiore iffues the Teffino; and from that of Como the Adda. Of the other lakes, that of Lugano and Guarda are the chief: that of Guarda was anciently called *Benacus*.

The trade and manufactures of this duchy confift principally in filks, ftuffs, ftockings, gloves, and handkerchiefs, linen and woollen cloth, hardware, curious works

works of cryſtal, agate, hyacinths, and other gems; but their exports are uſually far ſhort of their imports.

As to the revenue of the duchy, it muſt without doubt be very conſiderable. It is ſaid to have amounted to 2,000,000 of dollars while the duchy was in the hands of the Spaniards.

In the year 1767, the Auſtrian government of Milan publiſhed a law, by which all the rights which the pope or the biſhops had till then exerciſed over eccleſiaſtics, either with regard to their effects or perſons, is transferred to a council eſtabliſhed for that purpoſe at Milan. By the ſame edict, all eccleſiaſtics were obliged to ſell the eſtates which they had become poſſeſſed of ſince the year 1722; and no ſubject, whether eccleſiaſtic or ſecular, was to go to Rome to ſolicit any favour, except letters of indulgence, without the conſent of the ſaid council.

Milan, the capital of the duchy of that name, in Latin *Mediolanum*, is a very large city, and has a wall and rampart round it, with a citadel; yet is thought to be incapable of making any great reſiſtance. The gardens within the city take up a great deal of ground. In the citadel is a foundery for cannon, and an arſenal furniſhed with arms for 12,000 men. The governor of it is quite independent of the governor-general of the Milaneſe, who reſides in the city, in a large, but old and ill-contrived palace. The yearly income of the governor of Milan is ſaid to be 200,000 guilders. The council belonging to the city is compoſed of a preſident and 60 doctors of law, who are all nobles, and independent of the governor-general. Milan hath experienced a great variety of fortune, having been ſubject ſometimes to the French, ſometimes to the Spaniards, and ſometimes to the Germans. A great number of perſons of rank and fortune live in it, eſpecially during the winter. The ladies in France are not allowed more liberty than thoſe of this city: even the auſterities of the monaſtic life are ſo far mitigated here, that gentlemen have not only the liberty of talking with the nuns, and of rallying and laughing at the grate, but alſo of joining with them in concerts of muſic, and of ſpending whole afternoons in their company. The place where the *beau monde* take the air, either in their coaches or on foot, is the rampart betwixt the Porta Orientale, and the Porta Toſa, where it is ſtraight and broad, and extremely pleaſant, being planted with white mulberry-trees, and commanding a proſpect on one ſide of the open country, and on the other of the gardens and vineyards between the ramparts and the city. Milan, which is ſaid to have been built by the Gauls about 200 years after the foundation of Rome, contains a great number of ſtately edifices, as churches, convents, palaces, and hoſpitals. The cathedral is a vaſt pile, all of marble; and though ſomething has been doing for near 400 years towards the outward or inward ornament thereof, it is not yet finiſhed. Of the great number of ſtatues about it, that of St Bartholomew, juſt flead alive, with his ſkin hanging over his ſhoulders, and of Adam and Eve, over the main portal, are the fineſt. The pillars ſupporting the roof of the church are all of marble, and the windows finely painted. This church contains a treaſure of great value, particularly a ſhrine of rock-cryſtal, in which the body of St Charles Boromæo is depoſited. The other churches moſt worthy a ſtranger's notice are thoſe of St Alexander, St Jerom, St Giovanni di Caſarotti della Paſſione, that of the Jeſuits, and of St Ambroſe, in which lie the bodies of the ſaint, and of the kings Pepin and Bernard. In the Ambroſian college, founded by Frederic Boromæo, 16 profeſſors teach gratis. In the ſame college is alſo an academy of painting, with a muſæum, and a library, containing a vaſt number of printed books and manuſcripts; among the laſt of which is a tranſlation of Joſephus's Hiſtory of the Jews, done by Rufinus about 1200 years ago, and written on the bark of a tree; St Ambroſe's works on vellum, finely illuminated; the orations of Gregory Nazianzen, and the works of Virgil, in folio, with Petrarch's notes. In the muſæum are Leonardi da Vinci's mathematical and mechanical drawings, in 12 large volumes. The ſeminary for ſciences, the college of the nobles, the Helvetian college, and the mathematical academy, are noble foundations, and ſtately buildings. Of the hoſpitals, the moſt remarkable are the Lazaretto, and that called the *great hoſpital;* the latter of which receives ſick perſons, foundlings, and lunatics, and has ſix ſmaller hoſpitals depending on it, with a revenue of 100,000 rixdollars. The number of the inhabitants of this city is ſaid to be about 250,000. It has been 40 times beſieged, taken 20 times, and four times almoſt entirely demoliſhed; yet it hath always recovered itſelf. It is ſaid that gunpowder is ſold here only by one perſon, and in one place. The court of inquiſition is held in the Dominican convent, near the church of Madonna della Gratia. The houſes of entertainment, and the ordinaries here, are repreſented as very indifferent. Mr Keyſler ſays, it is not unuſual for young travellers, when they go to any of the taverns in Milan, to be aſked, "whether they chooſe a *letto fornito*, or female bed-fellow," who continues maſked till ſhe enters the bed-chamber. Deformed dwarfs, and people with wens, ſome of them of a prodigious ſize, are very common in the ſtreets of Milan. The wens are ſaid to be hereditary. The common method of burying here is, to throw the corpſes into vaults, without coffins, to the amount of two or three hundred, which cannot fail to fill the air in theſe places with noxious effluvia. Mr Keyſler tells us, that when he was at Milan, goods of any kind might have been brought into the city without ſearch or inquiry, provided a ſmall gratuity was given to the officer. Milan is far ſhort of Turin both in beauty and conveniency, many of the ſtreets being crooked and narrow, and paper-windows much more frequent than in that city; even in grand palaces, the windows are often compoſed promiſcuouſly of glaſs and paper. It is not uncommon here for beggars, when they aſk alms, to hold out to you a diſh, in which is a human ſkull. Two large canals extend from hence, the one to the Teſſino, and the other to the Adda; the Teſſino having a communication with the Lago Maggiore, and, by a canal, with the Seſia; and the Adda iſſuing from the Lago di Como, and having a communication by canals with the Lambro and Serio. In a void ſpace in one of the ſtreets of Milan, where ſtood the houſe of a barber who had conſpired with the commiſſary of health to poiſon his fellow-citizens, is erected a pillar called *Colonna Infame*, with an inſcription to perpetuate the memory of

of the execrable defign. The environs of this city are very pleafant, being adorned with beautiful feats, gardens, orchards, &c. About two Italian miles from it, at the feat of the Simonetti family, is a building, that would have been a mafter-piece of its kind had the architect defigned it for an artificial echo. It will return or repeat the report of a piftol above 60 times; and any fingle mufical inftrument, well touched, will have the fame effect as a great number of inftruments, and produce a moft furprifing and delightful concert. E. Long. 15. 35. N. Lat. 38. 32.

MILBORN-PORT, a town of Somerfetfhire in England, feated on a branch of the river Parret, and fends two members to parliament. W. Long. 2. 28. N. Lat. 51. 5.

MILDEW is faid to be a kind of thick, clammy, fweet juice, exhaled from, or falling down upon, the leaves and bloffoms of plants. By its thicknefs and clamminefs it prevents perfpiration, and hinders the growth of the plant. It fometimes refts on the leaves of trees, in form of a fatty juice, and fometimes on the ears of corn. It is naturally very tough and vifcous, and becomes ftill more fo by the fun's heat exhaling its more fluid parts; by which means the young ears of corn are fo daubed over, that they can never arrive at their full growth. Bearded wheat is lefs fubject to the mildew than the common fort; and it is obferved, that newly-dunged lands are more liable to mildew than others. The beft remedy is a fmart fhower of rain, and immediately afterwards a brifk wind. If the mildew is feen before the fun has much power, it has been recommended to fend two men into the field with a long cord, each holding one end, and drawing this along the field through the ears, the dew will be diflodged from them, before the heat of the fun is able to dry it to that vifcous ftate in which it does the mifchief. Some alfo fay, that lands which have for many years been fubject to mildews, have been cured of it by fowing foot along with the corn, or immediately after it.

Mr J. S. Segar, the author of a treatife upon this fubject, obferves, that the mildew is of fuch a fharp corrofive nature, that it raifes blifters on the feet of the fhepherds who go barefoot, and even confumes the hoofs of the cattle. He fufpects that it poffeffes fome arfenical qualities, though he does not pretend to affirm this pofitively. Its pernicious influence, according to him, is rendered ftill more powerful by a variety of circumftances; fuch as fending the cattle into the fields too early in the fpring; their drinking water mixed with ice, or but lately thawed; their being kept in ftables that are too clofe and filthy, and which are not fufficiently aired. The fame author confiders the mildew as a principal caufe of epidemical diftempers among the cattle. The mildew producing thefe difeafes, he fays, is that which dries and burns the grafs and leaves. It falls ufually in the morning, particularly after a thunder-ftorm. Its poifonous quality (which does not continue above 24 hours) never operates but when it has been fwallowed immediately after its falling. The diforder attacks the ftomach, is accompanied with pimples on the tongue, lofs of appetite, a deficcation of the aliments in the ftomach, a cough, and difficulty of refpiration. As a prefervative, the author prefcribes purging in fpring and in winter. The medicine he advifes is compofed of 30 grains of fulphur of antimony, and 60 grains of refin of jalap. He is againft vomiting, and every thing that is of a heating nature.

MILE, a meafure of length or diftance, containing eight furlongs. The Englifh ftatute-mile is 80 chains, or 1760 yards; that is, 5280 feet.

We fhall here give a table of the miles in ufe among the principal nations of Europe, in geometrical paces, 60,000 of which make a degree of the equator.

	Geometrical paces.
Mile of Ruffia	750
of Italy	1000
of England	1200
of Scotland and Ireland	1500
Old league of France	1500
The fmall league, *ibid.*	2000
The mean league, *ibid.*	2500
The great league, *ibid.*	3000
Mile of Poland	3000
of Spain	3428
of Germany	4000
of Sweden	5000
of Denmark	5000
of Hungary	6000

MILETUS (anc. geogr.), a town of Crete mentioned by Homer; but where fituate does not appear. It is faid to be the mother-town of Miletus in Caria, whither a colony was led by Sarpedon, Minos's brother, (Ephorus, quoted by Strabo). *Milefii*, the people, (Ovid).

MILETUS (anc. geogr.), the capital of Ionia, formerly a leading and principal town in the arts of war and peace, (Mela); of great antiquity, (Nonnus); built by Miletus the companion of Bacchus, (Apollodorus); famous above all for its colonies, (Herodotus, Strabo). The only town that made head againft Alexander, and with much difficulty taken, (Arrian). The country of Thales, one of the feven wife men, and the firft who applied himfelf to the ftudy of nature. It was alfo the country of Anaximander, the fcholar and fucceffor of Thales, the inventor of fun-dials and the gnomon, and the firft that publifhed a geographical map; of Anaximenes, fcholar and fucceffor to the foregoing; and of other great men. It was famous for its excellent wool, according to Virgil. *Milefii*, the people; who, from being powerful, becoming afterwards opulent and abandoned to pleafures, loft both their riches and their power.

MILFOIL, or YARROW. See ACHILLEA.

MILFORD-HAVEN, one of the fineft harbours in Europe, and indifputably the beft in Britain, is fituated in Pembrokefhire in South-Wales, and lies on the north fide of the Briftol Channel. It is very large, fafe, and deep; there is no danger of going in or out with the tide, or almoft with any wind. If a fhip comes in without a cable or anchor, fhe may run afhore on the ooze, and there lie fafe till fhe is refitted; and in an hour's time fhe may get out of the harbour into the open fea. It lies extremely convenient for fhips bound from the Englifh or Briftol Channels to Ireland, or farther weft, and from thence to the Channels. It is faid, that 1000 fail of any fize may ride

ride secure in this haven. Yet Dr Campbell informs us, that, in some places, even this singular and wonderful haven is not safe. As, for instance, in Nangle-road, in Milford-haven, at about half-flood, all Nangle-flutch is covered; about the middle of which flutch or ooze there lie a parcel of straggling stones called the *Oyster-rocks;* most of them loose, and about four feet high, which renders the place very dangerous for ships which are obliged to run in there when it blows too hard in the road; and the more so, because they do not appear at low-water neap-tides, being quarter-tide stones. These, and some others on Nangle-point, may be removed at the expence of 100l.; but though the improvement and fortification of Milford-haven have been much talked of, and even a large sum granted by parliament for that purpose, very little hath been done, and it still continues in a great measure neglected. The pier, which lies now in ruins, would be very useful if repaired. In the time of queen Elizabeth, before the Spanish invasion, there were two forts begun at the entrance of Milford, one on each side, as may be seen in Speed's maps, called *Nangle* and *Dale Block-houses;* but they were never finished. The situation of these block-houses was very ill chosen, since a vessel being obliged to bring-to before she has well entered the mouth of the haven, may either drive ashore on the rocks, or miss the harbour. A small fort might be built on the Stack, and another on Sandy-haven Point, which would command the entrance of Milford-haven, and not be liable to the former objection, or in any way prejudice the shipping. Pennamouth is the opening of that branch of the haven upon which the town of Pembroke lies, where the custom-house of Milford is kept. The entrance, or breadth from rock to rock, is but 200 yards at high-water, and 112 at low-water, and from 9 to 12 feet deep. The navigation up this river to Pembroke-town is much impeded by the rubbish of the limestone-quarries being thrown into the river; which ought to be prevented, or the place will in time be stopped up. Within Pennamouth a dock might be made, which would contain all the shipping in England, and which would be the greatest thing of the kind in the whole world. Milford-haven contains five large bays, 13 good roads, and 16 safe creeks.

MILIARY, in general, something resembling millet-seed.

Miliary *Fever*. See Medicine, n° 336.

MILITANT, or Church-militant, denotes the body of Christians while here on earth.

MILITARY, something belonging to the soldiery or militia.

Military-*Discipline*, the training of soldiers, and the due enforcement of the laws and regulations instituted by authority for their conduct.

Next to the forming of troops, military discipline is the first object that presents itself to our notice: it is the soul of all armies; and unless it be established amongst them with great prudence, and supported with unshaken resolution, they are no better than so many contemptible heaps of rabble, which are more dangerous to the very state that maintains them, than even its declared enemies.

Military *Execution*, the ravaging or destroying of a country or town that refuses to pay the contribution inflicted upon them.

Military-*Exercise*. See Exercise and Words *of Command*.

Military-*State*, in British polity, one of the three divisions of the laity. See Laity.

This state includes the whole of the soldiery; or such persons as are peculiarly appointed among the rest of the people, for the safeguard and defence of the realm.

In a land of liberty, it is extremely dangerous to make a distinct order of the profession of arms. In absolute monarchies, this is necessary for the safety of the prince; and arises from the main principle of their constitution, which is that of governing by fear: but, in free states, the profession of a soldier, taken singly and merely as a profession, is justly an object of jealousy. In these no man should take up arms but with a view to defend his country and its laws: he puts not off the citizen when he enters the camp; but it is because he is a citizen, and would wish to continue so, that he makes himself for a while a soldier. The laws, therefore, and constitution of these kingdoms, know no such state as that of a perpetual standing soldier, bred up to no other profession than that of war: and it was not till the reign of Henry VII. that the kings of England had so much as a guard about their persons.

In the time of the Anglo-Saxons, as appears from Edward the confessor's laws, the military force of England was in the hands of the dukes or heretochs, who were constituted through every province and county in the kingdom; being taken out of the principal nobility, and such as were most remarkable for being *sapientes, fideles, et animosi.* Their duty was to lead and regulate the English armies, with a very unlimited power; *prout eis visum fuerit, ad honorem coronæ et utilitatem regni.* And because of this great power they were elected by the people in their full assembly, or folkmote, in the same manner as sheriffs were elected: following still that old fundamental maxim of the Saxon constitution, that where any officer was entrusted with such power, as, if abused, might tend to the oppression of the people, that power was delegated to him by the vote of the people themselves. So too, among the ancient Germans, the ancestors of our Saxon forefathers, they had their dukes, as well as kings, with an independent power over the military, as the kings had over the civil state. The dukes were elective, the kings hereditary: for so only can be consistently understood that passage of Tacitus, *Reges ex nobilitate, duces ex virtute sumunt.* In constituting their kings, the family or blood-royal was regarded; in choosing their dukes or leaders, warlike merit: just as Cæsar relates of their ancestors in his time, that whenever they went to war, by way either of attack or defence, they elected leaders to command them. This large share of power, thus conferred by the people, though intended to preserve the liberty of the subject, was perhaps unreasonably detrimental to the prerogative of the crown: and accordingly we find a very ill use made of it by Edric duke of Mercia, in the reign of king Edmond Ironside; who, by his office of duke or heretoch, was entitled to a large command in the king's army, and by his repeated treacheries

 cheries at laft transferred the crown to Canute the Dane.

It feems univerfally agreed by all hiftorians, that king Alfred firft fettled a national militia in this kingdom, and by his prudent difcipline made all the fubjects of his dominion foldiers: but we are unfortunately left in the dark as to the particulars of this his fo celebrated regulation; though, from what was laft obferved, the dukes feem to have been left in poffeffion of too large and independent a power: which enabled duke Harold on the death of Edward the confeffor, though a ftranger to the royal blood, to mount for a fhort fpace the throne of this kingdom, in prejudice of Edgar Atheling the rightful heir.

Upon the Norman conqueft, the feodal law was introduced here in all its rigour, the whole of which is built on a military plan. In confequence thereof, all the lands in the kingdom were divided into what were called knights fees, in number above 60,000; and for every knight's fee a knight or foldier, *miles*, was bound to attend the king in his wars, for 40 days in a year; in which fpace of time, before war was reduced to a fcience, the campaign was generally finifhed, and a kingdom either conquered or victorious. By this means the king had, without any expence, an army of 60,000 men always ready at his command. And accordingly we find one, among the laws of William the conqueror, which in the king's name commands and firmly enjoins the perfonal attendance of all knights and others; *quod habeant et teneant fe femper in armis et equis, ut decet et oportet: et quod femper fint prompti et parati ad fervitium fuum integrum nobis explendum et peragendum, cum opus adfuerit, fecundum quod debent de feodis et tenementis fuis de jure nobis facere.* This perfonal fervice in procefs of time degenerated into pecuniary commutations or aids; and at laft the military part of the feodal fyftem was abolifhed at the Reftoration, by ftatute 12 Car. II. c. 24. See FEODAL *Syftem.*

In the mean time we are not to imagine that the kingdom was left wholly without defence in cafe of domeftic infurrections, or the profpect of foreign invafions. Befides thofe who by their military tenures were bound to perform 40 days fervice in the field, firft the affife of arms, enacted 27 Hen. II. and afterwards the ftatute of Winchefter, under Edward I. obliged every man, according to his eftate and degree, to provide a determinate quantity of fuch arms as were then in ufe, in order to keep the peace; and conftables were appointed in all hundreds by the latter ftatute, to fee that fuch arms were provided. Thefe weapons were changed, by the ftatute 4 & 5 Ph. & M. c. 2. into others of more modern fervice; but both this and the former provifions were repealed in the reign of James I. While thefe continued in force, it was ufual from time to time for our princes to iffue commiffions of array, and fend into every county officers in whom they could confide, to mufter and array (or fet in military order) the inhabitants of every diftrict; and the form of the commiffion of array was fettled in parliament in the 5 Hen. IV. But at the fame time it was provided, that no man fhould be compelled to go out of the kingdom at any rate, nor out of his fhire, but in cafes of urgent neceffity; nor fhould provide foldiers unlefs by confent of parliament. About the reign of king Henry VIII. and his children, lord-lieutenants began to be introduced, as ftanding reprefentatives of the crown, to keep the counties in military order; for we find them mentioned as known officers in the ftatute 4 & 5 Ph. & M. c. 3. tho' they had not been then long in ufe; for Cambden fpeaks of them in the time of queen Elizabeth as extraordinary magiftrates, conftituted only in times of difficulty and danger.

In this ftate things continued till the repeal of the ftatutes of armour in the reign of king James I.; after which, when king Charles I. had, during his northern expeditions, iffued commiffions of lieutenancy, and exerted fome military powers which, having been long exercifed, were thought to belong to the crown, it became a queftion in the long-parliament, how far the power of the militia did inherently refide in the king; being now unfupported by any ftatute, and founded only upon immemorial ufage. This queftion, long agitated with great heat and refentment on both fides, became at length the immediate caufe of the fatal rupture between the king and his parliament: the two houfes not only denying this prerogative of the crown, the legality of which claim perhaps might be fomewhat doubtful; but alfo feizing into their hands the entire power of the militia, the illegality of which ftep could never be any doubt at all.

Soon after the reftoration of king Char. II. when the military tenures were abolifhed, it was thought proper to afcertain the power of the militia, to recognize the fole right of the crown to govern and command them, and to put the whole into a more regular method of military fubordination: and the order in which the militia now ftands by law, is principally built upon the ftatutes which were then enacted. It is true, the two laft of them are apparently repealed; but many of their provifions are re-enacted, with the addition of fome new regulations, by the prefent militia-laws: the general fcheme of which is to difcipline a certain number of the inhabitants of every county, chofen by lot for three years, and officered by the lord-lieutenant, the deputy-lieutenants, and other principal landholders, under a commiffion from the crown. They are not compellable to march out of their counties, unlefs in cafe of invafion or actual rebellion, nor in any cafe compellable to march out of the kingdom. They are to be exercifed at ftated times: and their difcipline in general is liberal and eafy; but, when drawn out into actual fervice, they are fubject to the rigours of martial law, as neceffary to keep them in order. This is the conftitutional fecurity which our laws have provided for the public peace, and for protecting the realm againft foreign or domeftic violence; and which the ftatutes declare is effentially neceffary to the fafety and profperity of the kingdom.

When the nation was engaged in war, more veteran troops and more regular difcipline were efteemed to be neceffary, than could be expected from a mere militia; and therefore at fuch times more rigorous methods were put in ufe for the raifing of armies and the due regulation and difcipline of the foldiery: which are to be looked upon only as temporary excrefcences bred out of the diftemper of the ftate, and not as any part of the permanent and perpetual laws of the kingdom. For martial law, which is built upon no fettled principles, but is entirely arbitrary in its decifions, is,

as

as Sir Matthew Hale obferves, in truth and reality no law, but fomething indulged rather than allowed as a law. The neceffity of order and difcipline in an army is the only thing which can give it countenance; and therefore it ought not to be permitted in time of peace, when the king's courts are open for all perfons to receive juftice according to the laws of the land. Wherefore, Thomas earl of Lancafter being conducted at Pontefract, 15 Edw. II. by martial law, his attainder was reverfed 1 Edw. III. becaufe it was done in time of peace. And it is laid down, that if a lieutenant, or other, that hath commiffion of martial authority, doth in time of peace hang or otherwife execute any man by colour of martial law, this is murder; for it is againft *magna carta*. And the petition of right enacts, that no foldier fhall be quartered on the fubject without his own confent; and that no commiffion fhall iffue to proceed within this land according to martial law. And whereas, after the Reftoration, king Ch. II. kept up about 5000 regular troops, by his own authority, for guards and garrifons; which king James II. by degrees increafed to no lefs than 30,000, all paid from his own civil lift; it was made one of the articles of the bill of rights, that the raifing or keeping a ftanding army within the kingdom in time of peace, unlefs it be with confent of parliament, is againft law.

But as the fafhion of keeping ftanding armies (which was firft introduced by Charles VII. in France, 1445) has of late years univerfally prevailed over Europe, (tho' fome of its potentates, being unable themfelves to maintain them, are obliged to have recourfe to richer powers, and receive fubfidiary penfions for that purpofe), it has alfo for many years paft been annually judged neceffary by our legiflature, for the fafety of the kingdom, the defence of the poffeffions of the crown of Great Britain, and the prefervation of the balance of power in Europe, to maintain even in time of peace a ftanding body of troops, under the command of the crown; who are however *ipfo facto* difbanded at the expiration of every year, unlefs continued by parliament. And it was enacted by ftatute 10 W. III. c. 1. that not more than 12,000 regular forces fhould be kept on foot in Ireland, tho' paid at the charge of that kingdom: which permiffion is extended by ftat. 8. Geo. III. c. 13. to 16,235 men in time of peace.

To prevent the executive power from being able to opprefs, fays baron Montefquieu, it is requifite that the armies with which it is entrufted fhould confift of the people, and have the fame fpirit with the people; as was the cafe at Rome, till Marius new-modelled the legions by enlifting the rabble of Italy, and laid the foundation of all the military tyranny that enfued. Nothing then, according to thefe principles, ought to be more guarded againft in a free ftate, than making the military power, when fuch a one is neceffary to be kept on foot, a body too diftinct from the people. Like ours, therefore, it fhould wholly be compofed of natural fubjects; it ought only to be enlifted for a fhort and limited time; the foldiers alfo fhould live intermixed with the people; no feparate camp, no barracks, no inland fortreffes fhould be allowed. And perhaps it might be ftill better, if, by difmiffing a ftated number, and enlifting others at every renewal of their term, a circulation could be kept up between the army and the people, and the citizen and the foldier be more intimately connected together.

To keep this body of troops in order, an annual act of parliament likewife paffes, "to punifh mutiny and defertion, and for the better payment of the army and their quarters." This regulates the manner in which they are to be difperfed among the feveral inn-keepers and victuallers throughout the kingdom; and eftablifhes a law-martial for their government. By this, among other things, it is enacted, that if any officer or foldier fhall excite, or join any mutiny, or, knowing of it, fhall not give notice to the commanding officer, or fhall defert, or lift in any other regiment, or fleep upon his poft, or leave it before he is relieved, or hold correfpondence with a rebel or enemy, or ftrike or ufe violence to his fuperior officer, or fhall difobey his lawful commands; fuch offender fhall fuffer fuch punifhment as a court-martial fhall inflict, tho' it extend to death itfelf.

However expedient the moft ftrict regulations may be in time of actual war, yet, in times of profound peace, a little relaxation of military rigour would not, one fhould hope, be productive of much inconvenience. And, upon this principle, tho' by our ftanding laws (ftill remaining in force, tho' not attended to) defertion in time of war is made felony without benefit of clergy, and the offence is triable by a jury and before the judges of the common law; yet, by our militia-laws beforementioned, a much lighter punifhment is inflicted for defertion in time of peace. So, by the Roman law alfo, defertion in time of war was punifhed with death, but more mildly in time of tranquillity. But our mutiny-act makes no fuch diftinction: for any of the faults abovementioned are, equally at all times, punifhable with death itfelf, if a court-martial fhall think proper. This difcretionary power of the court-martial is indeed to be guided by the directions of the crown; which, with regard to military offences, has almoft an abfolute legiflative power. "His Majefty (fays the act) may form articles of war, and conftitute courts-martial, with power to try any crime by fuch articles, and inflict fuch penalties as the articles direct." A vaft and moft important truft! an unlimited power to create crimes, and annex to them any punifhments not extending to life or limb! Thefe are indeed forbidden to be inflicted, except for crimes declared to be fo punifhable by this act; which crimes we have juft enumerated, and among which, we may obferve, that any difobedience to lawful commands is one. Perhaps in fome future revifion of this act, which is in many refpects haftily penned, it may be thought worthy the wifdom of parliament to afcertain the limits of military fubjection, and to enact exprefs articles of war for the government of the army, as is done for the government of the navy: efpecially as, by our prefent conftitution, the nobility and gentry of the kingdom, who ferve their country as militia officers, are annually fubjected to the fame arbitrary rule during their time of exercife.

One of the greateft advantages of our law is, that not only the crimes themfelves which it punifhes, but alfo the penalties which it inflicts, are afcertained and no-

notorious: nothing is left to arbitrary discretion: the king by his judges dispenses what the law has previously ordained; but is not himself the legislator. How much therefore is it to be regretted, that a set of men, whose bravery has so often preserved the liberties of their country, should be reduced to a state of servitude in the midst of a nation of freemen! for Sir Edward Coke will inform us, that it is one of the genuine marks of servitude, to have the law, which is our rule of action, either concealed or precarious: *Misera est servitus, ubi jus est vagum aut incognitum.* Nor is this state of servitude quite consistent with the maxims of sound policy observed by other free nations. For the greater the general liberty is which any state enjoys, the more cautious has it usually been in introducing slavery in any particular order or profession. These men, as baron Montesquieu observes, seeing the liberty which others possess, and which they themselves are excluded from, are apt (like eunuchs in the eastern seraglios) to live in a state of perpetual envy and hatred towards the rest of the community, and indulge a malignant pleasure in contributing to destroy those privileges to which they can never be admitted. Hence have many free states, by departing from this rule, been endangered by the revolt of their slaves: while, in absolute and despotic governments, where no real liberty exists, and consequently no invidious comparisons can be formed, such incidents are extremely rare. Two precautions are therefore advised to be observed in all prudent and free governments: 1. To prevent the introduction of slavery at all: or, 2. If it be already introduced, not to entrust those slaves with arms; who will then find themselves an overmatch for the freemen. Much less ought the soldiery to be an exception to the people in general, and the only state of servitude in the nation.

Blackst. Comment.

But as soldiers, by this annual act, are thus put in a worse condition than any other subjects; so, by the humanity of our standing laws, they are in some cases put in a much better. By statute 43 Eliz. c. 3. a weekly allowance is to be raised in every county for the relief of soldiers that are sick, hurt, and maimed: not forgetting the royal hospital at Chelsea for such as are worn out in their duty. Officers and soldiers, that have been in the king's service, are by several statutes, enacted at the close of several wars, at liberty to use any trade or occupation they are fit for, in any town in the kingdom (except the two universities), notwithstanding any statute, custom, or charter to the contrary. And soldiers in actual military service may make nuncupative wills, and dispose of their goods, wages, and other personal chattels, without these forms, solemnities, and expences, which the law requires in other cases. Our law does not indeed extend this privilege so far as the civil law, which carried it to an extreme that borders upon the ridiculous: for if a soldier, in the article of death, wrote any thing in bloody letters on his shield, or in the dust of the field with his sword, it was a very good military testament.

MILITARY *Court*. See CHIVALRY (*Court of*).

MILITARY *Tenures*. See TENURE, FEODAL SYSTEM, and KNIGHT.

MILITIA, in general, denotes the body of soldiers, or those who make profession of arms.

In a more restrained sense, militia denotes the trained bands of a town or country, who arm themselves, upon a short warning, for their own defence. So that, in this sense, militia is opposed to regular or stated troops. See MILITARY *State*, and FEODAL *System*.

MILIUM, MILLET; a genus of the digynia order, belonging to the triandria class of plants. There are five species, of which the most remarkable is the panicum or common millet. This is a native of India, but is now commonly cultivated in many parts of Europe as an esculent grain. It rises, with a reed-like stalk, three or four feet high, and channelled: at every joint there is one reed-like leaf, which is joined on the top of the sheath, and embraces and covers that joint of the stalk below the leaf: this sheath is closely covered with soft hairs, but the leaf which is expanded has none. The top of the stalk is terminated by a large loose panicle, which hangs on one side, having a chaffy flower, which is succeeded by a small round seed. There are two varieties; one with white, and the other with black seeds; but they do not differ in any other particular. This plant is greatly cultivated in the oriental countries, and from whence we are annually furnished with it. It is seldom cultivated in Britain but in small gardens, for feeding of poultry, where the seeds generally ripen very well. It is used as an ingredient in puddings, and is by some people greatly esteemed. The seeds must be sown in the beginning of April, upon a warm dry soil, but not too thick, because the plants divide into several branches, and should have much room. When they come up they should be cleaned from weeds; after which they will in a short time get the better of them, and prevent the future growth. In August the seeds will ripen, when the plant most be cut down, and the seeds beaten out as is practised for other grain; but if it is not protected from birds, they will devour it as soon as it begins to ripen.

MILK, a well-known fluid, prepared by nature in the breasts of women, and the udders of other animals, for the nourishment of their young.—According to Dr Cullen, milk is a connecting and intermediate substance between animals and vegetables. It seems immediately to be secreted from the chyle, both being a white liquor of the same consistence: it is most copiously secreted after meals, and of an acescent nature. In most animals who lives on vegetables, the milk is acescent; and it is uncertain, though at the same time no observation proves the contrary, whether it is not so likewise in carnivorous animals. But, whatever be in this, it is certain, that the milk of all animals who live on vegetables is acescent. Milk being derived from the chyle, we thence conclude its vegetable nature; for in those who live on both promiscuously, more milk is got, and more quickly, from the vegetable than the animal food. Milk, however, is not purely vegetable; though we have a vegetable liquor that resembles its taste, consistence, colour, acescency, and the separability of the oily part, viz. an emulsion of the nuces oleosæ and farinaceous substances. But these want the coagulable part of milk, which seems to be of animal-nature, approaching to that of the coagulable lymph of the blood. Milk, then, seems to be of an intermediate nature, between chyle taken

Lect. on Mat. Med.

up

Milk.

up from the inteftines and the fully elaborated animal-fluid.

Its contents are of three kinds: firft, an oily part, which, whatever may be faid concerning the origin of other oils in the body, is certainly immediately derived from the oil of the vegetables taken in, as with thefe it agrees very exactly in its nature, and would entirely if we could feparate it fully from the coagulable part. Another mark of their agreemen is the feparability, which proves that the mixture has been lately attempted, but not fully performed. 2dly, Befides this oily, there is a proper coagulable part: And, 3dly, Much water accompanies both, in which there is diffolved a faline faccharine fubftance. Thefe three can be got feparate in cheefe, butter, and whey; but never perfectly fo, a part of each being always blended with every other part.

Nothing is more common, from what has been faid of its immediate nature, than to fuppofe that it requires no affimilation; and hence has been deduced the reafon of its exhibition in the moft weakly ftate of the human body. But wherever we can examine milk, we always find that it coagulates, fuffers a decompofition, and becomes acefcent. Again, infants, who feed entirely on milk, are always troubled with eructations, which every body obferves are not of the fame quality with the food taken; and therefore it appears, that, like all other food, milk turns naturally acefcent in the ftomach, and only enters the chyle and blood in confequence of a new recompofition. It approaches then to the nature of vegetable aliment, but is not capable of its noxious vinous fermentation, and therefore has an advantage over it; neither from this quality, like animal-food, is it heating in the ftomach, and productive of fever; though at the fame time, from its quantity of coagulable matter, it is more nourifhing than vegetables.

Milk is the food moft univerfally fuited to all ages and ftates of the body; but it feems chiefly defigned by nature as the food of infants. When animals are in the fœtus-ftate, their folids are a perfect jelly, incapable of an affimilatory power. In fuch ftate nature has perfectly affimilated food, as the albumen ovi in the oviparous, and in the viviparous animals certainly fomewhat of the fame kind, as it was neceffary the veffels fhould be filled with fuch a fluid as would make way for an after-affimilation. When the infant has attained a confiderable degree of firmnefs, as when it is feparated from the mother, yet fuch a degree of weaknefs ftill remains as makes fomewhat of the fame indication neceffary, it behoves the infant to have an alkalefcent food ready prepared, and at the fame time its noxious tendency to be avoided. Milk then is given, which is alkalefcent, and, at the fame time, has a fufficient quantity of acidity to correct that alkalefcency. As the body advances in growth, and the alkalefcent tendency is greater, the animal, to obviate that tendency, is led to take vegetable food, as more fuited to its ftrength of affimilation.

Dr Cullen obferves, that milk is almoft fuited to all temperaments; and it is even fo to ftomachs difpofed to acefcency, more than thofe fubftances which have undergone the vinous fermentation; nay, it even cures the heart-burn, checks vinous fermentation, and precipitates the lees, when, by renewal of fermentation, the wine happens to be fouled. It therefore very properly accompanies a great deal of vegetable aliment; although fometimes its acefcency is troublefome, either from a large proportion taken in, or from the degree of it; for, according to certain unaccountable circumftances, different acids are formed in the ftomach in different ftates of the body; in a healthy body, *e. g.* a mild one; in the hypochondriac difeafe, one fometimes as corrofive as the foffil acid. When the acidity of milk is carried to a great degree, it may prove remarkably refrigerant, and occafion cold crudities, and the recurrence of intermittent fevers. To take the common notion of its paffing unchanged into the blood, it can fuffer no folution. But if we admit its coagulum in the ftomach, then it may be reckoned among foluble or infoluble foods, according as that coagulum is more or lefs tenacious. Formerly rennet, which is employed to coagulate milk, was thought an acid; but, from late obfervations, it appears, that, if it be an acid, it is very different from other acids, and that its coagulum is ftronger than that produced by acids. It has been imagined, that a rennet is to be found in the ftomachs of all animals, which caufes coagulation of milk; but, to Dr Cullen, the coagulation of milk feems to be owing to a weak acid in the ftomach, the relicts of our vegetable food, inducing, in healthy perfons, a weak and foluble coagulum; but in different ftomachs this may be very different, in thefe becoming heavy and lefs foluble food, and fometimes even evacuated in a coagulated undiffolved ftate both by ftomach and ftool.

As milk is acefcent, it may be rendered fometimes purgative by mixing with the bile; and fome examples of this have been remarked. More commonly, however, it is reckoned among thofe foods which occafion coftivenefs.

Hoffman, in his experiments on milk, found that all kinds of it contained much water; and when this was diffipated, found the refiduum very different in their folubility. But we muft not thence conclude, that the fame infolubility takes place in the ftomach; for extracts made from vegetables with water are often very infoluble fubftances, and hardly diffufible through water itfelf: therefore, in Hoffman's extracts, if we may fo call them, of milk, fomewhat of the fame kind might have appeared; and thefe fubftances, which in their natural ftate were not fo, might appear very infoluble. However, we may allow that milk is always fomehow infoluble in the inteftines, as it is of a drying nature, and, as cheefe, &c. is very coftive. And this effect fhows that milk is always coagulated in the ftomach; for if it remained fluid, no fæces would be produced, whereas fometimes very hard ones are obferved. In the blood-veffels, from its animal-nature, it may be confidered as nutritious; but when we confider its vegetable contents, and acefcency in the primæ viæ, we find, that, like animal-food, it does not excite that degree of fever in the time of digeftion, and that from its acefcency it will refift putrefaction. Hence its ufe in hectic fevers, which, whatever be their caufe, appear only to be exacerbations of natural feverifh paroxyfms, which occur twice every day, commonly after meals, and at night. To obviate thefe, therefore, we give fuch an aliment as produces the leaft exacerbation of thefe fevers; and of this nature is milk, on

 on account of its acefcent vegetable nature.

There appears alfo fomewhat peculiar to milk, which requires only a fmall exertion of the animal-powers in order to its affimilation; and befides, in hectic complaints there is wanted an oily, bland food, approaching to the animal-nature: fo that on all thefe accounts, milk is a diet peculiarly adapted to them, and, in general, to moft convalefcents, and to thofe of inflammatory temperaments.—So far of milk in general.—We fhall now fpeak of the particular kinds which are in common ufe.

The milk of women, mares, and affes, agree very much in their qualities, being very dilute, having little folid contents, and, when evaporated to drynefs, having thefe very foluble, containing much faccharine matter, of a very ready acefcency, and, when coagulated, their coagulum being tender and eafily broke down. From this view they have lefs oil, and feem to have lefs coagulable matter, than the reft.

The milk of cows, fheep, and goats, agree, in oppofite qualities to the three juft mentioned; but here there is fomewhat more of gradation. Cows milk comes neareft to the former milk: goats milk is lefs fluid, lefs fweet, lefs flatulent, has the largeft proportion of infoluble part after coagulation, and indeed the largeft proportion of coagulable part; its oily and coagulable parts are not fpontaneoufly feparable, never throwing out a cream, or allowing butter to be readily extracted from it. Hence the virtues of thefe milks are obvious, being more nourifhing, though, at the fame time, lefs eafily foluble in weak ftomachs, than the three firft, lefs acefcent than thefe, and fo more rarely laxative, and peculiarly fitted for the diet of convalefcents without fever. The three firft, again, are lefs nourifhing, more foluble, more laxative, as more acefcent, and adapted to the convalefcents with fever.

Thefe qualities, in particular milks, are confiderably diverfified by different circumftances. Firft, Different animals, living on the fame diet, give a confiderably different milk; for there feems to be fomething in the conftitution, abftracting from the aliment, which conftitutes a confiderable diverfity of milk, not only in the fame fpecies of animals, but alfo in the fame animal, at different ages, and at different diftances after delivery: this applies to the choice of nurfes. Secondly, Milk follows the nature of the aliment more than any other juice in the human body, being more or lefs fluid and dilute, more or lefs folid and nourifhing, in proportion as thefe qualities are more or lefs in the aliment. The nature of the aliment differs according to its time of growth, *e. g.* old grafs being always found more nourifhing than young. Aliment, too, is always varied according to the feafon, as that is warm or dry, moift or cloudy.

The milk of each particular kind of animal is fitter for particular purpofes, when fed on proper food. Thus the cow delights in the fucculent herbage of the vale: if the fheep be fed there he certainly rots, but on the higher and more dry fide of the mountain he feeds pleafantly and healthy; while the goat never ftops near the bottom, but afcends to the craggy fummit: and certainly the milks of thefe animals are always beft on their proper foil, and that of goats is beft on a mountainous country. From a differtation of Linnæus, we have many obfervations concerning the diverfity of plants on which each animal choofes to feed. All the Swedifh plants which could be collected together, were prefented alternately to domeftic animals, and then it appeared that the goat lived on the greateft variety, and even on many which were poifonous to the reft; that the cow chofe the firft fucculent fhoots of the plant, and neglected the fructification; which laft was preferred by the goat. Hence may be deduced rules concerning the pafturage of different animals; *e. g.* Farmers find, that, in a pafture which was only fit to feed a certain number of fheep, an equal number of goats may be introduced, while the fheep are no lefs nourifhed than before.

It is not eafy to affign the difference between milk frefh-drawn and that detained in the open air for fome time; but certainly there is fome material one, otherwife nature univerfally would not have directed infants to fucking; and indeed it feems, better than the other, fitted for digeftion and nourifhment. Phyficians have fuppofed that this depended on the evaporation of fome *fpt. rector.* but our author cannot conceive any fuch, except common water here; and befides, thefe volatile parts can hardly be nutritious. A more plaufible account feems deducible from mixture: milk, new drawn, has been but lately mixed, and is expofed to fpontaneous feparation, a circumftance hurtful to digeftion; none of the parts being, by themfelves, fo eafily affimilated as when they are all taken together. Hence, then, milk new-drawn is more intimately blended, and therefore then is moft proper to the weakly and infants.

Another difference in the ufe of milk expofed for fome time to the air, is taking it boiled or unboiled. Phyficians have generally recommended the former; but the reafon is not eafily affigned. Perhaps it is this: Milk kept for fome time expofed to the air has gone fo far to a fpontaneous feparation; whereas the heat thoroughly blends the whole, and hence its refolution is not fo eafy in the ftomach; and thus boiled milk is more coftive than raw, and gives more fæces. Again, when milk is boiled, a confiderable quantity of air is detached, as appears from the froth on the furface; and air is the chief inftrument of fermentation in bodies; fo that, after this procefs, it is not liable to acefcency: for thefe reafons it is proper for the robuft and vigorous.

Another difference of milk is, according as it is fluid or coagulated. The coagulated is of two kinds, as induced by rennet, or the natural acefcency of the milk. The former preparation makes the firmer and lefs eafily foluble coagulum; though, when taken with the whey unfeparated, it is lefs difficult of folution, tho' more fo than any other coagulum in the fame cafe. Many nations ufe the latter form, which is eafier foluble, but very much acefcent, and therefore, in point of folution, fhould be confined to the vigorous, in point of acefcency, to thofe who live on alkalefcent food; and in the laft cafe the Laplanders ufe it as their chief acefcent condiment. From the fame confiderations it is more cooling, and in its other effects like all other acefcent vegetables.

Milk.

Milk by evaporation yields a ſweet ſaline matter, of which Dr Lewis gives the following proportions:

Twelve ounces of	Left of dry matter	From which water extracted a ſweet ſaline ſubſtance amounting to
Cows milk	13 drams.	$1\frac{1}{2}$ drams.
Goats milk	$12\frac{1}{2}$	$1\frac{1}{2}$
Human milk	8	6
Affes milk	8	6

The ſaline ſubſtance extracted from affes milk was white, and ſweet as ſugar; thoſe of the others brown, or yellow, and conſiderably leſs ſweet; that from cows milk had the leaſt ſweetneſs of any.

On diſtilling 12 quarts of milk *in balneo mariæ*, at leaſt nine quarts of pure phlegm were obtained: the liquor which afterwards aroſe was acidulous, and by degrees grew ſenſibly more and more acid as the diſtillation was continued. After this came over a little ſpirit, and at laſt an empyreumatic oil. The remaining ſolid matter adhered to the bottom of the retort, in the form of elegant ſhining black flowers, which being calcined and elixated yielded a portion of fixed alkaline ſalt.

Milk, ſet in a warm place, throws up to the ſurface an unctuous cream, from which, by agitation, the butter is eaſily ſeparated. The addition of alkaline ſalts prevents this ſeparation, not (as ſome have ſuppoſed) by abſorbing an acid from the milk, but by virtue of their property of intimately uniting oily bodies with watery liquors. Sugar, another grand intermedium betwixt oils and water, has this effect in a greater degree, though that concrete is by no means alkaline, or an abſorbent of acids.

The ſweet ſaccharine part of the milk remains diſſolved in the whey after the ſeparation of the curd or cheeſy matter, and may be collected from it in a white cryſtalline form, by boiling the whey till all remains of the curdled ſubſtance have fallen to the bottom; then filtering, evaporating it to a due conſiſtence, ſetting it to ſhoot, and purifying the cryſtals by ſolution in water and a ſecond cryſtallization. Much has been ſaid of the medicinal virtues of this ſugar of milk, but it does not ſeem to have any conſiderable ones: It is from cows milk that it has been generally prepared; and the cryſtals obtained from this kind of milk have but little ſweetneſs.

When milk is ſuffered to coagulate ſpontaneouſly, the whey proves acid, and on ſtanding grows more and more ſo till the putrefactive ſtate commences. Sour whey is uſed as an acid, preferably to the directly vegetable or the mineral acids, in ſome of the chemical arts; as for diſſolving iron in order to the ſtaining of linen and leather. This acid was commonly made uſe of in the bleaching of linen, for diſſolving and extracting the earthy particles left in the cloth by the alkaline ſalts and lime employed for cleanſing and whitening it. Butter-milk is preferred to plain ſour-milk or ſour-whey: This laſt is ſuppoſed to give the cloth a yellow colour. Dr Home, in his ingenious treatiſe on this ſubject, recommends water acidulated with ſpirit of vitriol, (in the proportion of about half an ounce, or at moſt three quarters of an ounce, to a gallon), as preferable in many reſpects to the acid of milk, or of the more directly vegetable ſubſtances. He obſerves, that the latter are often difficultly procurable, abound with oleaginous particles, and haſten to corruption; whilſt the vitriolic acid is cheap, and pure, and indiſpoſed to putrefy: That milk takes five days to perform its office, whilſt the vitriolic acid does it in as many hours, perhaps in as many minutes: That this acid contributes alſo to whiten the cloth, and does not make it weaker though the cloth be kept in it for months. He finds, that acids as well as alkalies, extract an oily matter from the cloth, and loſe their acidity and alkalicity. Since this treatiſe appeared, the uſe of ſour-milk is very generally ſuperſeded by oil of vitriol.

It is obſervable, that affes milk is greatly diſpoſed, on ſtanding for a little time, to become thick and ropy. In the Breſlau collection for the year 1720, there is a remarkable account of milk (which probably was that of the aſs) grown ſo thick and tenacious as to be drawn out into long ſtrings, which, when dried, were quite brittle.

New cows milk, ſuffered to ſtand for ſome days on the leaves of butterwort or ſun-dew, becomes uniformly thick, ſlippery, and coherent, and of an agreeable ſweet taſte, without any ſeparation of its parts. Freſh milk, added to this, is thickened in the ſame manner, and this ſucceſſively. In ſome parts of Sweden, as we are informed in the Swediſh Memoirs, milk is thus prepared for food.

New milk has a degree of glutinous quality, ſo as be uſed for joining broken ſtone-ware. There is a far greater tenacity in cheeſe properly prepared.

Milk, when examined by a microſcope, appears compoſed of numerous globules ſwimming in a tranſparent fluid. It boils in nearly the ſame degree of heat with common water; ſome ſorts rather ſooner, and ſome a little later: after boiling, it is leſs diſpoſed to grow ſour than in its natural ſtate. It is coagulated by acids both mineral and vegetable, and by alkalies both fixed and volatile. The coagulum made by acids falls to the bottom of the ſerum; that made by alkalies ſwims on the ſurface, commonly forming (eſpecially with volatile alkalies) a thick coriaceous ſkin. The ſerum, with alkalies, proves green or ſanious; with acids, it differs little in appearance from the whey that ſeparates ſpontaneouſly. The coagulum formed by acids is diſſolved by alkalies, and that formed by alkalies is re-diſſolved by acids; but the milk does not in either caſe reſume its original properties. It is coagulated by moſt of the middle ſalts, whoſe baſis is an earth or a metallic body; as ſolution of alum, fixed ſal ammoniac, ſugar of lead, green and blue vitriol: but not by the chalybeate or purging mineral waters, nor by the bitter ſalt extracted from the purging waters. Among the neutral ſalts that have been tried, there is not one that produces any coagulation. They all dilute the milk, and make it leſs diſpoſed to coagulate with acids or alkalies: Nitre ſeems to have this effect in a greater degree than the other neutral ſalts. It is inſtantly coagulated by highly-rectified ſpirit of wine, but ſcarcely by a phlegmatic ſpirit. It does not mingle with expreſſed oils. All the coagula are diſſolved by gall.

Milk *of Lime. Milk of Sulphur*. The name of *milk* is given to ſubſtances very different from *milk* properly ſo

so called, and which resemble milk only in colour. Such is water in which quicklime has been slaked, which acquires a whiteness from the small particles of the lime being suspended in it, and has hence been called the *milk of lime*. Such also is the solution of liver of sulphur, when an acid is mixed with it, by which white particles of sulphur are made to float in the liquor.

MILK *of Vegetables*. For the same reason that milk of animals may be considered as a true animal-emulsion, the emulsive liquors of vegetables may be called *vegetable milks*. Accordingly emulsions made with almonds are commonly called *milk of almonds*. But besides this vegetable milk, which is in some measure artificial, many plants and trees contain naturally a large quantity of emulsive or milky juices. Such are lettuce, spurge, fig-tree, and the tree which furnishes the elastic American resin. The milky juices obtained from all these vegetables derive their whiteness from an oily matter, mixed and undissolved in a watery or mucilaginous liquor. Most resinous gums were originally such milky juices, which afterwards become solid by the evaporation of their most fluid and volatile parts.

These natural milky juices have not been examined by any chemist. Such an examination would, however, procure much essential knowledge concerning vegetable œconomy. We should probably find examples of all kinds of oils reduced into milky juices; and this knowledge cannot fail of throwing much light on the nature of resins and gum-resins.

MILK-*Fever*. See MIDWIFERY, Chap. XX.

MILL, a machine for grinding corn, &c. of which there are various kinds, according to the different methods of applying the moving power; as water-mills, wind-mills, mills worked by horses, &c. See MECHANICS.

The first obvious method of reducing corn into flour for bread would be, by the simple expedient of pounding. And that was for ages the only one which was practised by the various descendants of Adam, and actually continued in use among the Romans below the reign of Vespasian. But the process was very early improved by the application of a grinding power, and the introduction of mill-stones. This, like most of the common refinements in domestic life, was probably the invention of the antediluvian world, and certainly practised in some of the earliest ages after it. And, like most of them, it was equally known in the east and west. Hence the Gauls and Britons appear familiarly acquainted with the use of hand-mills before the time of their submission to the Romans; the Britons particularly distinguishing them, as the Highlanders and we distinguish them at present, by the simple appellation of *querns*, *carnes*, or *stones*. And to these the Romans added the very useful invention of water-mills. For this discovery the world is pretty certainly indebted to the genius of Italy; and the machine was not uncommon in the country at the conquest of Lancashire. This, therefore, the Romans would necessarily introduce with their many other refinements among us. And that they actually did, the British appellation of a *water-mill* fully suggests of itself; the *melin* of the Welsh and Cornish, the *mull*, *meill*, and *melin* of the Armoricans, and the Irish *muilean* and *muilind*, being all evidently derived from the Roman *mola* and *molendinum*. The subject Britons universally adopted the Roman name, but applied it, as we their successors do, only to the Roman *mill*; and one of these was probably erected at every stationary city in the kingdom. One plainly was at Manchester, serving equally the purposes of the town, and the accommodation of the garrison. *Whitaker's Hist. of Manchester.* And one alone would be sufficient, as the use of hand-mills remained very common in both, many having been found about the site of the station particularly; and the general practice having descended among us nearly to the present period. Such it would be peculiarly necessary to have in the camp, that the garrison might be provided against a siege. And the water-mill at Manchester was fixed immediately below the Castle-field and the town, and on the channel of the Medlock. There, a little above the ancient ford, the sluice of it was accidentally discovered about 30 years ago. On the margin of Dyer's-croft, and opposite to some new constructions, the current of the river, accidentally swelled with the rains, and, obstructed by a dam, broke down the northern bank, swept away a large oak upon the edge of it, and disclosed a long tunnel in the rock below. This has been since laid open in part with a spade. It appeared entirely uncovered at the top, was about a yard in width, and another in depth, but gradually narrowed to the bottom. The sides shewed every-where the marks of the tool on the rock, and the course of it was parallel with the channel. It was bared by the flood about 25 yards only in length, but was evidently continued for several further; having originally begun, as the nature of the ground evinces, just above the large curve in the channel of the Medlock.

For the first five or six centuries of the Roman state, there were no public bread-bakers in the city of Rome. They were first introduced into it from the east, at the conclusion of the war with Perseus, and about the year 167 before Christ. And, towards the close of the first century, the Roman families were supplied by them every morning with fresh loaves for breakfast. But the same custom, which prevailed originally among the Romans and many other nations, has continued nearly to the present time among the Mancunians. The providing of bread for every family was left entirely to the attention of the women in it. And it was baked upon stones, which the Welsh denominate *greidiols* and we *gredles*. It appears, however, from the kiln-burnt pottery which has been discovered in the British sepulchres, and from the British appellation of an *odyn* or *oven* remaining among us at present, that furnaces for baking were generally known among the original Britons. An odyn would, therefore, be erected at the mansion of each British baron, for the use of himself and his retainers. And, when he and they removed into the vicinity of a Roman station, the oven would be rebuilt with the mansion, and the public bakehouses of our towns commence at the first foundation of them. One bakehouse would be constructed, as we have previously shewn one mill to have been set up, for the public service of all the Mancunian families. One oven and one mill appear to have been equally established in the town. And the inhabitants of it appear immemorially accustomed to bake at the one and grind at the other. Both, therefore, were in all pro-

bability conſtructed at the firſt introduction of water-mills and ovens into the country. The great ſimilarity of the appointments refers the conſideration directly to one and the ſame origin for them. And the general nature of all ſuch inſtitutions points immediately to the firſt and actual introduction of both. And, as the ſame eſtabliſhments prevailed equally in other parts of the north, and pretty certainly obtained over all the extent of Roman Britain, the ſame erections were as certainly made at every ſtationary town in the kingdom.

MILL (John), a very learned divine, was born at Shap in Weſtmoreland, about the year 1645; and became a ſervitor of Queen's college Oxford. On his entering into orders he became an eminent preacher, and was made prebendary of Exeter. In 1681, he was created doctor of divinity; about the ſame time he was made chaplain in ordinary to king Charles II. and in 1685 he was elected principal of St Edmund's hall in Oxford. His edition of the Greek Teſtament, which will ever render his name memorable, was publiſhed about a fortnight before his death, which happened in June 1707. Dr Mill was employed 30 years in preparing this edition.

MILLENARIANS, or Chiliasts, a name given to thoſe, in the primitive ages, who believed that the ſaints will reign on earth with Chriſt 1000 years.

The Millenarians held, that after the coming of Antichriſt, and the deſtruction of all nations which ſhall follow, there ſhall be a firſt reſurrection of the juſt alone: that all who ſhall be found upon earth, both good and bad, ſhall continue alive; the good, to obey the juſt who are riſen, as their princes; the bad, to be conquered by the juſt, and to be ſubject to them: that Jeſus Chriſt will then deſcend from heaven in his glory: that the city of Jeruſalem will be rebuilt, enlarged, embelliſhed, and its gates ſtand open night and day. They applied to this new Jeruſalem what is ſaid in the Apocalypſe, chap. xxi. and to the temple all that is written in Ezekiel xxxvi. Here, they pretended, Jeſus Chriſt will fix the ſeat of his empire, and reign 1000 years with the ſaints, patriarchs, and prophets, who will enjoy perfect and uninterrupted felicity.

This reign of our Saviour on earth is uſually ſtyled the *millennium*, or reign of 1000 years.

MILLEPES, or wood-louse, in zoology; a ſpecies of Oniscus. Theſe inſects are found in cellars, under ſtones, and in cold moiſt places; in the warmer countries they are rarely met with. Millepedes have a faint diſagreeable ſmell, and a ſomewhat pungent, ſweetiſh, nauſeous taſte. They have been highly celebrated in ſuppreſſions of urine, in all kinds of obſtructions of the bowels, in the jaundice, weakneſs of ſight, and a variety of other diſorders. Whether they have any juſt title to theſe virtues is greatly to be doubted: thus much is certain, that their real effects come far ſhort of the character uſually given them.

MILLET, in botany. See Milium.

MILLING of Cloth. See Fulling.

MILLION, in arithmetic, the ſum of ten hundred thouſand, or a thouſand times a thouſand. See Arithmetic.

MILLO, a part of mount Zion at its extremity; and therefore called *Millo*, of the city of David, (2 Chron. xxxii.) taken in with the wall that encompaſſed mount Zion. Uncertain whether *Beth-Millo*, (Judges ix. 20.) denotes a place; if it did, it lay near Sechem.

MILO, an iſland in the Archipelago, about 50 miles in circumference, with a harbour, which is one of the largeſt and beſt of the Mediterranean, and which ſerves for a retreat for all the ſhips that go to or return from the Mediterranean. The inhabitants are all Greeks, except the cadi, or judge, who is a Turk. Salt is ſo cheap, that they ſell 67 pounds for ſevenpence. There are two biſhops, the one of the Greek, and the other of the Latin church; and there are 13 monaſteries in this iſland. In the ſpring the whole iſland is like a carpet thick ſet with anemonies of all ſorts and colours. There are public baths at the foot of a ſmall hill going from the town to the harbour; they are in a cavern, with a very narrow entrance of 50 paces long. When a perſon is got in, the ſweat guſhes out in large drops; and this ſweating is eſteemed good for the palſy, rheumatiſm, and other diſeaſes. Below theſe baths, near the ſhore, there are many little ſprings, ſo hot as to ſcald one's fingers. Four miles from the town, in a very ſteep place by the ſea, is a grotto, 15 paces deep, which is all cruſted over with plume-alum, in ſome places as white as ſnow, and reddiſh in others. Some paces from this cavern, on the ſea-ſhore, is another grotto, whoſe bottom is filled with ſulphur, which burns continually. Thoſe who are troubled with the itch go and ſweat here, and are generally cured. Near the chapel of St Surriacus is a ſpot of ground continually burning; and the fields about it are always ſmoking, and yet they are all covered with marigolds. Though the air of Milo is very unwholeſome, yet the inhabitants lead a merry life, and regale themſelves very cheap; but the women are not very famous for chaſtity. They have partridges, turtle-doves, quails, wheat-ears, wood-pigeons, and ducks, in great plenty; as alſo good figs, melons, excellent grapes, and very delicate fiſh. The principal town is of the ſame name as the iſland, and contains near 5000 inhabitants. It is prettily built, but abominably naſty; the houſes are two ſtories high, with flat roofs, and are built with a ſort of pumice-ſtone, which is hard, blackiſh, and yet very light. This iſland is 60 miles north of Candia, and the town is ſituated in E. Long. 25. 15. N. Lat. 36. 27.

MILT, in anatomy, a popular name for the ſpleen.

Milt, or *Melt*, in natural hiſtory, the ſoft roe in fiſhes; thus called by reaſon it yields, by expreſſion, a whitiſh juice reſembling milk. See Roe.

The milt is properly the ſeed or ſpermatic part of the male fiſh. The milt of a carp is reckoned a choice bit. It conſiſts of two long whitiſh irregular bodies, each included in a very thin fine membrane. M. Petit conſiders them as the teſticles of the fiſh wherein the ſeed is preſerved; the lower part, next the anus, he takes for the *veſiculæ ſeminales*.

MILTIADES, a celebrated Athenian captain, who, with 12,000 men, routed above 300,000 Perſians at Marathon, and, purſuing them, took many iſlands in the Archipelago: but returning to Athens without taking Paros, his fellow-citizens, forgetting the important ſervices he had rendered them, ſentenced him to pay a large fine. Being unable to advance the money, he was thrown into priſon, where he languiſh-

ed out the remainder of his days.

MILTON (John), the moſt illuſtrious of the Engliſh poets, was deſcended of a genteel family, ſeated at a place of their own name, viz. *Milton*, in Oxfordſhire. He was born December 9. 1608, and received his firſt rudiments of education under the care of his parents, aſſiſted by a private tutor. He afterwards paſſed ſome time at St Paul's ſchool, London; in which city his father had ſettled, being engaged in the buſineſs of a ſcrivener. At the age of 17, he was ſent to Chriſt's college, Cambridge; where he made a great progreſs in all parts of academical learning; but his chief delight was in poetry. In 1698, he proceeded bachelor of arts, having performed his exerciſe for it with great applauſe. His father deſigned him for the church; but the young gentleman's attachment to the muſes was ſo ſtrong, that it became impoſſible to engage him in any other purſuits. In 1632, he took the degree of maſter of arts; and having now ſpent as much time in the univerſity as became a perſon who determined not to engage in any of the three profeſſions, he left the college, greatly regretted by his acquaintance, but highly diſpleaſed with the uſual method of training up youth there for the ſtudy of divinity; and being much out of humour with the public adminiſtration of eccleſiaſtical affairs, he grew diſſatisfied with the eſtabliſhed form of church-government, and diſliked the whole plan of education practiſed in the univerſity. His parents, who now dwelt at Horton, near Colnbrook, in Buckinghamſhire, received him with unabated affection, notwithſtanding he had thwarted their views of providing for him in the church, and they amply indulged him in his love of retirement; wherein he enriched his mind with the choiceſt ſtores of Grecian and Roman literature: and his poems of *Comus*, *L'Allegro*, *Il Penſeroſo*, and *Lycidas*, all wrote at this time, would have been ſufficient, had he never produced any thing more conſiderable, to have tranſmitted his fame to lateſt poſterity. However, he was not ſo abſorbed in his ſtudies as not to make frequent excurſions to London; neither did ſo much excellence paſs unnoticed among his neighbours in the country, with the moſt diſtinguiſhed of whom he ſometimes choſe to relax his mind, and improve his acquaintance with the world as well as with books.

After five years ſpent in this manner, he obtained his father's permiſſion to travel for farther improvement.—At Paris he became acquainted with the celebrated Hugo Grotius; and from thence travelling into Italy, he was every where careſſed by perſons of the moſt eminent quality and learning.

Upon his return home, he ſet up a genteel academy in Alderſgate-ſtreet.—In 1641, he began to draw his pen in defence of the Preſbyterian party; and the next year he married the daughter of Richard Powell, Eſq; of Foreſt-Hill in Oxfordſhire. This lady, however, whether from a difference on account of party, her father being a zealous royaliſt, or ſome other cauſe, ſoon thought proper to return to her relations; which ſo incenſed her huſband, that he reſolved never to take her again, and wrote and publiſhed ſeveral tracts in defence of the doctrine and diſcipline of divorce. He even made his addreſſes to another lady; but this incident proved the means of a reconciliation with Mrs Milton.

In 1644, he wrote his Tract upon Education; and the reſtraint on the liberty of the preſs being continued by act of parliament, he wrote boldly and nobly againſt that reſtraint.

In 1645, he publiſhed his juvenile poems; and about two years after, on the death of his father, he took a ſmaller houſe in High Holborn, the back of which opened into Lincoln's-Inn Fields.—Here he quietly proſecuted his ſtudies, till the fatal cataſtrophe and death of Charles I.; on which occaſion he publiſhed his Tenure of Kings and Magiſtrates, in juſtification of the fact. He was now taken into the ſervice of the commonwealth, and made Latin ſecretary to the council of ſtate, who reſolved neither to write to others abroad, nor to receive any anſwers, except in the Latin tongue, which was common to them all. The famous Εἰκὼν Βασιλικὴ coming out about the ſame time, our author, by command, wrote and publiſhed his *Iconoclaſtes* the ſame year. It was alſo by order of his maſters, backed by the reward of 1000l. that, in 1651, he publiſhed his celebrated piece, entitled *Pro Populo Anglicano Defenſio*, "A Defence of the People of England, in anſwer to Salmaſius's Defence of the King;" which performance ſpread his fame over all Europe.—He now dwelt in a pleaſant houſe, with a garden, in Petty France, Weſtminſter, opening into St James's Park. In 1652, he buried his wife, who died not long after the delivery of her fourth child; and about the ſame time he alſo loſt his eye-ſight, by a *gutta ſerena*, which had been growing upon him many years.

Cromwell took the reins of government into his own hands in the year 1653; but Milton ſtill held his office. His leiſure-hours he employed in proſecuting his ſtudies, wherein he was ſo far from being diſcouraged by the loſs of his ſight, that he even conceived hopes this misfortune would add new vigour to his genius; which, in fact, ſeems to have been the caſe.—Thus animated, he again ventured upon matrimony: his ſecond lady was the daughter of Captain Woodcock of Hackney: ſhe died in childbed about a year after.

On the depoſition of the protector, Richard Cromwell, and on the return of the long parliament, Milton being ſtill continued ſecretary, he appeared again in print; pleading for a farther reformation of the laws relating to religion; and, during the anarchy that enſued, he drew up ſeveral ſchemes for re-eſtabliſhing the commonwealth, exerting all his faculties to prevent the return of Charles II. England's deſtiny, however, and Charles's good fortune, prevailing, our author choſe to conſult his ſafety, and retired to a friend's houſe in Bartholomew-Cloſe. A particular proſecution was intended againſt him; but the juſt eſteem to which his admirable genius and extraordinary accompliſhments entitled him, had raiſed him ſo many friends, even among thoſe of the oppoſite party, that he was included in the general amneſty.

This ſtorm over, he married a third wife Elizabeth, daughter of Mr Minſhall a Cheſhire gentleman; and not long after he took a houſe in the Artillery Walk, leading to Bunhill-Fields.—This was his laſt ſtage: here he ſat down for a longer continuance than he had been able to do any where; and though he had loſt his fortune, (for every thing belonging to him went to wreck

wreck at the Reſtoration), he did not loſe his taſte for literature, but continued his ſtudies with almoſt as much ardour as ever; and applied himſelf particularly to the finiſhing his grand work, the *Paradiſe Loſt;* one of the nobleſt poems that ever was produced by human genius.—It was publiſhed in 1667, and his *Paradiſe Regained* came out in 1670.—This latter work fell ſhort of the excellence of the former production; although, were it not for the tranſcendent merit of the Paradiſe Loſt, the ſecond compoſition would doubtleſs have ſtood foremoſt in the rank of Engliſh epic poems.—After this he publiſhed many pieces in proſe; for which we refer our readers to the edition of his Hiſtorical, Poetical, and Miſcellaneous Works, printed by Millar, in 2 vols 4to. in 1753.

In 1674, this great man paid the laſt debt to nature, at his houſe in Bunhill-Fields, in the 66th year of his age; and was interred on the 12th of November, in the chancel of St Giles's, Cripplegate.—A decent monument was erected to his memory, in 1737, in Weſtminſter Abbey, by Mr Benſon, one of the auditors of the impreſt.—As to his perſon, it was remarkably handſome; but his conſtitution was tender, and by no means equal to his inceſſant application to his ſtudies.—Though greatly reduced in his circumſtances, yet he died worth 1500l. in money, beſide his houſehold goods.—He had no ſon; but left behind him three daughters, whom he had by his firſt wife.

MILVIUS, Molvius, or *Mulvius Pons*, a bridge on the Tiber, built by Æmilius Scaurus the cenſor, in the time of Sylla, at two miles diſtance from the city, on the Via Flaminia, and repaired by Auguſtus. From this bridge the ambaſſadors of the Allobroges were brought back to Rome, by Cicero's management, and made a diſcovery of Catiline's conſpiracy (Salluſt.) Near it Maxentius was defeated by Conſtantine, (Eutropius.) Now called *Ponte Molle*.

Milvius, in ornithology, a ſpecies of Falco.

MIME, in the ancient comedy, a perſon who acted any character by mere geſtures, and hence denominated *pantomime*. See Pantomime.

MIMESIS, in rhetoric, the imitating the voice and geſtures of another perſon.

MIMNERMUS, an ancient poet and muſician, flouriſhed about the beginning of the 6th century B. C. He was of Smyrna, and cotemporary with Solon. Athenæus gives him the invention of pentameter verſe. His elegies, of which only a few fragments are preſerved, were ſo much admired in antiquity, that Horace preferred them to thoſe of Callimachus. He compoſed a poem of this kind, as we learn from Pauſanias, upon the battle fought between the people of Smyrna, and the Lydians, under Gyges. He likewiſe was author of a poem in elegiac verſe, quoted by Strabo, which he intitled *Nanno*, and in which we may ſuppoſe he chiefly celebrated a young and beautiful girl of that name, who, according to Athenæus, was a player on the flute, with whom he was enamoured in his old age. With reſpect to love-matters, according to Propertius, his verſes were more valuable than all the writings of Homer.

Plus in amore valet Mimnermi verſus Homero.
Lib. i. Eleg. 9. v. 11.

And Horace bears teſtimony to his abilities, in deſcribing that ſeducing paſſion:

Si Mimnermus uti cenſet, ſine amore jociſque
Nil eſt jucundum, vivas in amore jociſque.
Epiſt. VI. Lib. i. v. 65.

If, as wiſe Mimnermus ſaid,
Life unbleſt with love and joy,
Ranks us with the ſenſeleſs dead,
Let theſe gifts each hour employ.

Alluding to ſome much admired lines of this Greek poet, which have been preſerved by Stobæus.

Τις δε βιος, τι δε τερπνον ατερ χρυσης Ἀφροδιτης, &c.

What is life and all its pride,
If love and pleaſure be denied?
Snatch, ſnatch me hence, ye fates, whene'er
The am'rous bliſs I ceaſe to ſhare.
Oh let us crop each fragrant flow'r,
While youth and vigour give us pow'r;
For frozen age will ſoon deſtroy
The force to give or take a joy;
And then, a prey to pain and care,
Deteſted by the young and fair,
The ſun's bleſt beams will hateful grow,
And only ſhine on ſcenes of wo!

MIMOSA, the sensitive plant; a genus of the monœcia order, belonging to the polygamia claſs of plants.

This genus compriſes ſhrubby and herbaceous plants, but moſtly of the ſhrub kind, ſome trailing, others erect, all natives of the Indies, &c. retained here in ſtoves as great curioſities, particularly for the very ſingular ſenſibility of the leaves of ſome ſorts, which on being touched, ſuddenly recede, contract, and fall down in a very wonderful manner: all of them garniſhed with pinnated leaves, and monopetalous, funnel-ſhaped, five-parted, polygamous flowers at the axillas and ends of the branches in cluſters and ſpikes.

The name *mimoſa* of this genus, ſignifies mimic, originating from the ſenſibility of the leaves, which, by their motion, mimic or imitate, as it were, the motions of animals.

To this genus Linnæus joins many of the *acacias*, and it compriſes upwards of 40 different ſpecies; tho' not more than a quarter of them are common in the Engliſh gardens, or poſſeſs any particular merit either for curioſity or ornament, and none for uſe. Of the ſorts cultivated here in our ſtoves, &c. ſome are of the ſhrub and tree kind, and two or three are herbaceous perennials and annuals; are moſtly of the ſenſitive kinds, except the acacia ſorts, which are motionleſs, as expreſſed under their proper heads, i. e. ſenſitive and humble kinds, and ſenſeleſs kinds. The former of which are exceedingly curious plants in the very ſingular circumſtance of their leaves receding rapidly from the touch: the leaves are winged, each compoſed of numerous ſmall lobes, all of which on being touched, haſtily run up cloſe together; and in ſome ſorts the footſtalks and all are affected, ſo as inſtantly to fall downward, as if faſtened by hinges.

Shrubby, Senſitive, and Humble Kinds.

They have all winged leaves, each wing conſiſting of many ſmall pinnæ; ſome only contract the lobes of the leaves and pinnæ at the touch; others not only contract every part of their leaves, but their footſtalks alſo ſuddenly drop downward; and for diſtinction ſake, the former are called *ſenſitive mimoſas*, and the latter *humble ſenſitives;* but the leaves of both ſorts ſoon recover their uſual poſition. The moſt remarkable ſpecies are,

1. Sensitiva, or common sensitive humble plant. Rises with an undershrubby prickly stem, branching six or eight feet high, armed with crooked spines; conjugated, pinnated leaves, with bijugated partial lobes, or wings, having the inner ones the least, each leaf on a long footstalk; and at the sides and ends of the branches many purple flowers in roundish heads; succeeded by broad, flat, jointed pods, in radiated clusters.

This is somewhat of the humble sensitive kind; the leaves, footstalks and all, recede from the touch, though not with such facility as in some of the following sorts.

2. The pudica, or bashful humble plant. Rises with an undershr.bby, declinated, prickly stem, branching two or three feet around, armed with hairy spines; pinnated, digitated leaves, each leaf being of five or more long folioles, attached by their base to a long footstalk, and spread out above like the fingers of a hand; a d at the sides and ends of the branches roundish heads of greenish white flowers, succeeded by small, jointed, prickly pods.

This is truly of the humble sensitive kind; for by the least touch the leaves instantly recede, contract close, and, together with the footstalk, quickly decline downward, as if ashamed at the approach of the hand.

3. The pernambucana, or pernambuca slothful mimosa. Hath undershrubby, procumbent, unarmed stems, branching two or three feet around; bipinnated leaves, of three or four pair of short, winged foliola; and at the axillas drooping spikes of pentandrous flowers, the lower ones castrated.

This sort recedes very slowly from the touch, only contracting its pinnæ a little when smartly touched; hence the name *slothful mimosa*.

4. The asperata, or rough sensitive mimosa, hath a shrubby, upright, prickly, hairy, rough stem, branching four or five feet high, armed with short, broad, whitish spines; bipinnated, prickly leaves, of five or six pair of foliola, or wings, arranged opposite, having two thorns between each pair; and at the upper axillas globular heads of purple flowers, succeeded by short, flat, jointed pods, in clusters, spreading each way like a radius.

This is only moderately sensitive in its foliola, but not in the footstalks.

5. The punctata, or punctated sensitive mimosa, rises with a shrubby, upright, taper, punctated, or spotted, unarmed stem, branching erectly five or six feet high; bipinnated leaves, of four or five pair of long, winged folioles, having each about 20 pair of pinnæ; and at the axillas and termination of the branches oblong spikes of yellowish decandrous flowers, the inferior ones castrated; succeeded above by oblong seed-pods. This sort, though naturally shrubby and perennial in its native soil, yet in this country it sometimes decays in winter. It is only sensitive in the foliola, but quick in the motion.

Herbaceous Sensitive and Humble Kinds.

Of these sorts two are perennial of the trailing kind; and one is annual, of somewhat erect growth; have all winged leaves, with the wings formed of many small pinnæ.

6. The viva,—perennial, or lively sensitive mimosa, hath herbaceous, trailing, unarmed, repent stems, very branchy, spreading widely around, rooting at the joints as they advance; conjugated pinnated leaves, with quadrijugated, roundish, partial lobes, or wings; and at the axillas globular heads of yellowish flowers; succeeded by short, flat, jointed pods.

This species is only sensitive in the foliola; but is the most lively of that kind, it being so susceptible that all the folliola recede rapidly from the least touch, whereby it has the distinctive appellation of *vivacious*, or *lively mimosa*.

7. The quadrivalvis;—perennial, or quadrivalve humble mimosa, hath herbaceous slender, quadrangular, prickly stems, branching and spreading all around, armed with recurved spines; bipinnated leaves of two or three pair of winged lobes, having each many pinnæ; and at the axillas globular heads of purple flowers, succeeded by quadrivalvular pods.

This is of the humble sensitive kind, both leaves and footstalks recede from the touch.

8. The plena,—annual, or double-flowered sensitive annual mimosa, rises with an herbaceous, erect, round, unarmed stem, closely branching and spreading every way, three or four feet high; bipinnated leaves of four or five pair of winged lobes, of many pairs of pinnæ; and at the axillas and termination of the branches spikes of yellow pentandrous flowers, the lower ones double; succeeded by short broad pods.

This annual is only sensitive in the folliola, but extremely sensible of the touch or air.

Shrubby Insensible Kinds.

These are of the acacia kind, formerly a distinct genus, but now all species of Mimosa; but their leaves are destitute of motion or sensibility at the touch: there are about three noted species in the English gardens, all for the stove.

9. The cornigera, or horned Mexican mimosa, commonly called *great horned acacia*, hath a shrubby, upright, deformed stem, branching irregularly, armed with very large, horned-like white spines, by pairs, connated at the base; bipinnated leaves thinly placed; and flowers growing in spikes.

This species is esteemed a curiosity for the oddity of its large spines, resembling the horns of animals, and which are often variously wreathed, twisted, and contorted.

10. The farnesiana, or farnesian fragrant acacia, hath a shrubby stem, branching many feet high, armed with distinct spines; bipinnated leaves, having eight pair of partial lobes, or wings; and globular, close-sitting spikes of yellow sweet-scented flowers.

11. The nilotica, or nilotic true Egyptian acacia, hath an upright tree-stem, branching many feet high, armed with spreading spines; bipinnated leaves; and globular spikes of flowers, having footstalks. From the exsudation of the leaves of this sort is procured the drugs called *succus acaciæ* and *gum-arabic*.

Propagation, &c. These 11 species of mimosa are the most noted sorts in the English gardens; all the shrubby kinds are durable in root, stem, and branches; those of the perennial herbaceous kinds are also often abiding; but the annual sort always perish, root and branch, at the approach of winter. They are all natives of the Indies; and in this country require the continual shelter of a hot-house, or of a hot-bed of similar

lar temperature under frames and glaſſes; though they can hardly be ſupported alive in winter unleſs placed in a ſtove; ſo all the ſorts muſt conſtantly be kept in pots, and placed principally in that department, eſpecially during the winter; nor will they ſucceed well in the open air in ſummer, except about a month during the greateſt heat; but the ſenſitive and humble kinds, if expoſed to the open air, even in the hotteſt days, will be deprived of their ſenſibility during the time they remain ſo expoſed, therefore ſhould always be kept under glaſſes, in a ſtove if poſſible; or in default of ſuch a convenience, the plants might be raiſed from ſeed in ſpring in any common hot-bed under frames, &c. as directed for tender annuals, and continued conſtantly under the glaſſes, and thereby will afford pleaſure all ſummer by the oddity of their ſenſitive foliage; however, to have them to remain in perfection the year round, ſome muſt be continued always in a ſtove, as before obſerved; for the warmer they are kept, the ſtronger will be their ſenſible quality: but for a particular account of this quality, ſee the article SENSITIVE *Plant*.

The propagation of all the ſorts, both ſenſitives and acacias, is by ſeed in ſpring in a hot-bed, or in the bark-bed in the ſtove; and ſome of the ſenſitive kinds alſo by layers and cuttings.

MINA, in Grecian antiquity, a money of account, equal to 100 drachms.

MIND, a thinking intelligent being, otherwiſe called *ſpirit*, in oppoſition to matter, or body.

MINDANOA, a large iſland of Aſia in the Eaſt Indies, and one of the Philippines; 180 miles in length, and 120 in breadth. It is a very mountainous country, full of hills and valleys, and the mould is generally deep, black, and fruitful. The ſides of the hills and valleys are ſtony, and yet there are tall trees of kinds not known in Europe: ſome of the mountains yield very good gold, and the valleys are watered with variety of rivulets. The palm-trees † produce the ſago, which the poor people eat, inſtead of bread, three or four months in the year. They have here all ſorts of fruits proper to the climate, beſides plenty of rice: ſome affirm that there are nutmegs and cloves, but none of the trees that bear them appear near the coaſt. They have horſes, beeves, buffaloes, goats, deer, monkeys, lizards, and ſnakes; but they have neither lions nor tygers. Their hogs are very ugly creatures, having all great knobs growing over their eyes; however, their fleſh is ſweet. Their fowls are ducks, hens, pigeons, parrots, paroquets, turtle-doves, and bats as large as kites, beſides many ſmall birds. The air is temperate, they having breezes by day, and cooling land-winds at night. The winds are eaſterly one part of the year, and weſterly the other: while the former blow, it is fair weather; but while the latter, it is rainy, ſtormy, and tempeſtuous. The inhabitants are of a mean low ſtature, with ſmall limbs and little heads. Their faces are oval, with flat foreheads, black ſmall eyes, ſhort low noſes, and pretty large mouths. Their hair is black and ſtrait, and their complexion tawney, but more inclining to yellow than that of other Indians. The women are very deſirous of the company of ſtrangers, eſpecially white men. The chief trades are goldſmiths, blackſmiths, and carpenters; and they can build pretty good veſſels for the ſea. Their diſtempers are as in other places, except the leproſy, which is very common here. The ſultan has a queen, beſides 20 other women, and all the men have ſeveral wives; for their religion is Mahometaniſm. Their houſes are built on poſts, from 14 to 20 feet high; and they have ladders to go up out of the ſtreets. They have but one floor, which is divided into ſeveral rooms; and the roofs are covered with palmeto leaves. Thoſe that have been far up in the country ſay, that the people are all blacks, and go quite naked. The principal town, of the ſame name, is pretty large, and is ſeated on the eaſtern coaſt.

† See *Palma*.

MINDELHEIM, a town of Germany, in the circle of Suabia, and in Algow, with a caſtle. It is capital of a ſmall territory between the rivers Iler and Lech, ſubject to the houſe of Bavaria. It was taken by the Imperialiſts after the battle of Hochſtet, who erected it into a principality in favour of the duke of Marlborough; but it returned back to the houſe of Bavaria by the treaty of Raſtat. It is 33 miles ſouth-eaſt of Ulm. E. Long. 10. 40. N. Lat. 48. 5.

MINDELHEIM, a diſtrict of Germany, in Suabia, lying between the biſhopric of Augſburgh and the abbacy of Kempten, which is 20 miles in length and 16 in breadth.

MINDEN, a conſiderable town of Germany, in the circle of Weſtphalia, and capital of a territory of the ſame name; ſeated on the river Weſer, which renders it a trading-place. It belongs to the king of Pruſſia, who has ſecularized the biſhopric. It is 27 miles eaſt-by-ſouth of Oſnaburg, and 37 weſt of Hanover. E. Long. 9. 5. N. Lat. 52. 22.

MINDEN (the principality of), in Germany, lies in the circle of Weſtphalia, to the north of the county of Ravenſberg, and along each ſide of the river Weſer. It is about 22 miles ſquare, and Minden and Peterſhagen are the principal places. It was formerly a biſhopric, but is now ſecularized; and was ceded to the elector of Brandenburg by the treaty of Weſtphalia.

MINDORA, an iſland of Aſia, in the Eaſt Indies, and one of the Philippines, 50 miles in circumference, and ſeparated from Luconia by a narrow channel. It is full of mountains, which abound in palm-trees and all ſorts of fruits. The inhabitants are idolaters, and pay tribute to the Spaniards, to whom this iſland belongs.

MINE, in natural hiſtory, a place under ground, where metals, minerals, or even precious ſtones, are dug up.

As, therefore, the matter dug out of mines is various, the mines themſelves acquire various denominations, as *gold mines*, *ſilver mines*, *copper mines*, *iron mines*, *diamond mines*, *ſalt mines*, *mines of antimony*, *of alum*, &c.

Mines, then, in general, are veins or cavities within the earth, whoſe ſides receding from, or approaching nearer to each other, make them of unequal breadths in different places, ſometimes forming larger ſpaces, which are called *holes*: they are filled with ſubſtances, which, whether metallic or of any other nature, are called the *loads*; when the ſubſtances forming theſe loads are reducible to metal, the loads are by the miners ſaid to be alive, otherwiſe they are called *dead loads*. In Cornwall and Devon, the loads always

hold their courſe from eaſtward to weſtward; though in other parts of England they frequently run from north to ſouth. The miners report, that the ſides of the load never bear in a perpendicular, but conſtantly under-lay either to the north or to the ſouth. The load is frequently intercepted by the croſſing of a vein of earth or ſtone, or ſome different metallic ſubſtance; in which caſe it generally happens that one part of the load is moved a conſiderable diſtance to the one ſide. This tranſient load is by the miners called *flooking;* and the part of the lead which is to be moved is ſaid to be heaved.

According to Dr Nicols's obſervations upon mines, they ſeem to be, or to have been, the channels thro' which the waters paſs within the earth, and, like rivers, have their ſmall branches opening into them in all directions. Moſt mines have ſtreams of water running through them: and when they are found dry, it ſeems to be owing to the waters having changed their courſe, as being obliged to it, either becauſe the load has ſtopped up the ancient paſſages, or that ſome new and more eaſy ones are made.

Mines, ſays Dr Shaw, are liable to many contingencies; being ſometimes poor, ſometimes ſoon exhauſtible, ſometimes ſubject to be drowned, eſpecially when deep, and ſometimes hard to trace. Yet there are many inſtances of mines proving highly advantageous for hundreds of years: the mines of Potoſi are to this day worked with nearly the ſame ſucceſs as at firſt; the gold mines of Cremnitz have been worked almoſt theſe 1000 years; and our Corniſh tin mines are extremely ancient. The neat profit of the ſilver alone, dug in the Miſnian ſilver-mines in Saxony, is ſtill, in the ſpace of eight years, computed at a thouſand ſix hundred and forty-four millions, beſides ſeventy-three tons of gold. Many mines have been diſcovered by accident: a torrent firſt laid open a rich vein of the ſilver-mine at Friburg in Germany; ſometimes a violent wind, by blowing up trees, or overturning the parts of rocks, has diſcovered a mine; the ſame has happened by violent ſhowers, earthquakes, thunder, the firing of woods, or even the ſtroke of a ploughſhare or horſe's hoof.

But the art of mining does not wait for theſe favourable accidents, but directly goes upon the ſearch and diſcovery of ſuch mineral veins, ores, or ſands, as may be worth the working for metal. The principal inveſtigation and diſcovery of mines depend upon a particular ſagacity, or acquired habit of judging from particular ſigns, that metallic matters are contained in certain parts of the earth, not far below its ſurface. The principal ſigns of a latent metallic vein ſeem reducible to general heads; ſuch as, 1. The diſcovery of certain mineral waters. 2. The diſcolouration of the trees or graſs of a place. 3. The finding of pieces of ore on the ſurface of the ground. 4. The riſe of warm exhalations. 5. The finding of metallic ſands, and the like. All which are ſo many encouragements for making a ſtricter ſearch near the places where any thing of this kind appears; whence rules of practice might be formed for reducing this art to a greater certainty. But when no evident marks of a mine appears, the ſkilful mineraliſt uſually bores into the earth, in ſuch places as, from ſome analogy of knowledge, gained by experience, or by obſerving the ſituation, courſe, or nature of other mines, he judges may contain metal. As to the power of the divining wand in diſcovering mines, it ſeems to be a mere chimera. See *Divining-*WAND.

After the mine is found, the next thing to be conſidered, is whether it may be dug to advantage. In order to determine this, we are duly to weigh the nature of the place, and its ſituation, as to wood, water, carriage, healthineſs, and the like; and compare the reſult with the richneſs of the ore, the charge of digging, ſtamping, waſhing, and ſmelting.

Particularly the form and ſituation of the ſpot ſhould be well conſidered. A mine muſt either happen, 1. In a mountain. 2. In a hill. 3. In a valley. Or, 4. In a flat. But mountains and hills are dug with much greater eaſe and convenience, chiefly becauſe the drains and burrows, that is, the adits or avenues, may be here readily cut, both to drain the water and to form gang-ways for bringing out the lead, &c. In all the four caſes, we are to look out for the veins which the rains, or other accidental thing, may have laid bare; and if ſuch a vein be found, it may often be proper to open the mine at that place, eſpecially if the vein prove tolerably large and rich: otherwiſe the moſt commodious place for ſituation is to be choſe for the purpoſe, *viz.* neither on a flat, nor on the tops of mountains, but on the ſides. The beſt ſituation for a mine, is a mountainous, woody, wholeſome ſpot; of a ſafe eaſy aſcent, and bordering on a navigable river. The places abounding with mines are generally healthy, as ſtanding high, and every where expoſed to the air; yet ſome places, where mines are found, prove poiſonous, and can upon no account be dug, tho' ever ſo rich: the way of examining a ſuſpected place of this kind, is to make experiments upon brutes, by expoſing them to the effluvia or exhalations, to find the effects.

Devonſhire and Cornwall, where there are a great many mines of copper and tin, is a very mountainous country, which gives an opportunity in many places to make adits, or ſubterraneous drains, to ſome valley at a diſtance, by which to carry off the water from the mine, which otherwiſe would drown them out from getting the ore. Theſe adits are ſometimes carried a mile or two, and dug at a vaſt expence, as from 2000 l. to 4000 l. eſpecially where the ground is rocky; and yet they find this cheaper than to draw up the water out of the mine quite to the top, when the water runs in plenty, and the mine is deep. Sometimes, indeed, they cannot find a level near enough to which an adit may be carried from the very bottom of the mine; yet they find it worth while to make an adit at half the height to which the water is to be raiſed, thereby ſaving half the expence.

The late Mr Coſtar, conſidering that ſometimes from ſmall ſtreams, and ſometimes from little ſprings or collections of rain-water, one might have a good deal of water above ground, though not a ſufficient quantity to turn an overſhot-wheel, thought, that if a ſufficient fall might be had, this collection of water might be made uſeful in raiſing the water in a mine to the adit, where it may be carried off.

But now the moſt general method of draining mines is by the fire or ſteam engine. See STEAM-*Engine.*

Mine, in the military art, denotes a fubterraneous canal or paffage, dug under the wall or rampart of a fortification, intended to be blown up by gun-powder.

The alley or paffage of a mine is commonly about four feet fquare; at the end of this is the chamber of the mine, which is a cavity about five feet in width and in length, and about fix feet in height; and here the gun-powder is ftowed. The fauciffe of the mine is the train, for which there is always a little aperture left. There are various kinds of mines, which acquire various names, as *royal mines*, *ferpentine mines*, *forked mines*, according as their paffages are ftraight, oblique, winding, &c.

MINERAL, in natural hiftory, is ufed in general for all foffile bodies, whether fimple or compound, dug out of a mine; from whence it takes its denomination.

Mineral *Waters*. All waters naturally impregnated with any heterogeneous matter which they have diffolved within the earth may be called *mineral waters*, in the moft general and extenfive meaning of that name; in which are therefore comprehended almoft all thofe that flow within or upon the furface of the earth, for almoft all thefe contain fome earth or felenites. But waters containing only earth or felenites are not generally called *mineral*, but *hard* or *crude waters*.

Hard waters, which are fimply felenitic, when tried by the chemical proofs, fhew no marks of an acid or of an alkali, nor of any volatile, fulphureous, or metallic matters. Waters which contain a difengaged calcareous earth, change the colour of fyrup of violets to a green; and thofe that contain felenites, being mixed with a folution of mercury in nitrous acid, form a turbith mineral; and when a fixed alkali is added, they are rendered turbid, and a white fediment is precipitated. Thefe waters alfo do not diffolve foap well. From thefe we may know, that any water which produces thefe effects is a hard, earthy, or felenitic water. The waters impregnated with gas are alfo hard.

Although the waters of the fea and faline fprings be not generally enumerated amongft mineral waters, they might neverthelefs be juftly confidered as fuch: for befides earthy and felenitic matters, they alfo contain a large quantity of mineral falts. We fhall therefore confider them as fuch in this article.

Mineral waters, properly fo called, are thofe in which gas, or fulphureous, faline, or metallic fubftances, are difcovered by chemical trials. As many of thefe waters are employed fuccefsfully in medicine, they are alfo called *medicinal waters*.

Mineral waters receive their peculiar principles by paffing through earths containing falts, or pyritous fubftances that are in a ftate of decompofition. Some of thefe waters are valuable from the quantity of ufeful falts which they contain, particularly of common falt, great quantities of which are obtained from thefe waters; and others are chiefly valued for their medicinal qualities. The former kind of mineral waters is an object of manufacture, and from them is chiefly extracted that falt only which is moft valuable in commerce. See Salt.

Many of thefe waters have been accurately analyfed by able chemifts and phyficians. But notwithftanding thefe attempts, we are far from having all the certainty and knowledge that might be defired on this important fubject; for this kind of analyfis is perhaps the moft difficult of any in chemiftry.—Almoft all mineral waters contain feveral different fubftances, which being united with water may form with each other numberlefs compounds. Frequently fome of the principles of mineral waters are in fo fmall quantity, that they can fcarcely be perceived; altho' they may have fome influence on the virtues of the water, and alfo on the other principles contained in the water. The chemical operations ufed in the analyfis of mineral waters, may fometimes occafion effential changes in the fubftances that are to be difcovered. And alfo, thefe waters are capable of fuffering very confiderable changes by motion, by reft, and by expofure to air.

Probably alfo the variations of the atmofphere, fubterranean changes, fome fecret junction of a new fpring of mineral or of pure water, laftly the exhauftion of the minerals whence waters receive their peculiar principles, are caufes which may occafionally change the quality of mineral waters.

We need not therefore wonder that the refults of analyfes of the fame mineral waters made by different chemifts, whofe fkill and accuracy are not queftioned, fhould be very different.

The confequences of what we have faid on this fubject are, That the examination of mineral waters is a very difficult tafk; that it ought not to be attempted but by profound and experienced chemifts; that it requires frequent repetitions, and at different times; and laftly, that no fixed general rules can be given concerning thefe analyfes.

As this matter cannot be thoroughly explained without entering into details connected with all the parts of chemiftry, we fhall here mention only the principal refults, and the moft effential rules, that have been indicated by the attempts hitherto made on this fubject.

We may admit the divifion or arrangement of mineral waters into certain claffes, propofed by fome of the beft chemifts and naturalifts.

Some of thefe waters are called *cold*, becaufe they are not naturally hotter than the atmofphere. Some of them are even colder, efpecially in fummer.

Thofe are called *hot mineral waters*, which in all feafons are hotter than the air. Thefe are of various degrees of heat, and fome of them are almoft as hot as boiling water. In fome mineral waters certain volatile, fpirituous, and elaftic principles may be perceived, by a very fenfible piquant tafte: this principle is called the *gas* or the *fpirit of waters*.

The waters which contain this principle are generally lighter than pure water. They fparkle and emit bubbles, at their fpring, but efpecially when they are fhook, and poured from one veffel into another. They fometimes break the bottles containing them, when thefe are well corked, as fermenting wines fometimes do. When mixed with ordinary wine, they give to it the piquancy and fparkling quality of Champaigne wine.

This volatile principle, and all the properties of the water dependent upon it, are loft merely by expofure to air, or by agitation. The waters containing this principle are diftinguifhed by the name of *fpirituous mineral waters*, or *acidulous waters*.

Other

Other divifions of mineral waters may be made relatively to fome of their predominant principles. Hence fome waters are called *acidulous*, *alkaline*, *martial*, *neutral*, &c.

When a mineral water is to be examined, we may obferve the following rules:

Experiments ought to be made near the fpring, if poffible.

The fituation of the fpring, the nature of the foil, and the neighbouring rifing grounds, ought to be examined.

Its fenfible qualities, as its fmell, tafte, colour, are to be obferved.

Its fpecific gravity and heat are to be afcertained by the hydroftatical balance and the thermometer.

From the properties above-mentioned of fpirituous mineral waters, we may difcover whether it be one of this clafs. For greater certainty we may make the following trial. Let the neck of a wet bladder be tied to the neck of a bottle containing fome of this water. By fhaking the water, any gas that it may contain will be difengaged, and will fwell the bladder. If the neck of the bladder be then tied with a ftring above the bottle, and be cut below this ftring, fo as to feparate the bladder from the bottle, the quantity and nature of the contained gas may be further examined.

Laftly, we muft obferve the changes that are fpontaneoufly produced upon the water in clofe and in open veffels, and with different degrees of heat. If by thefe means any matter be cryftallized or depofited, it muft be fet apart for further examination.

Thefe preliminary experiments and obfervations will almoft certainly indicate, more or lefs fenfibly, fomething concerning the nature of the water, and will point out the method to be followed in our further inquiry.

We muft then proceed to the decompofition of the water, either without addition, and merely by evaporation and diftillation, or with the addition of other fubftances, by means of which the matters contained in the water may be precipitated and difcovered. It is not material which of thefe two methods be firft practifed, but it is quite neceffary that the one fhould fucceed the other. If we begin by evaporating and diftilling, thefe operations muft be fometimes interrupted, that the feveral principles which rife at different times of the diftillation may be obtained and examined feparately, and alfo to allow the feveral falts that may be contained to cryftallize by the evaporation and by cold.

The fubftances generally found in mineral waters, are almoft always combinations of vitriolic acid, and thofe of marine acid, together with the feveral matters that thefe acids are capable of diffolving.

The following combinations of vitriolic acid are found in mineral waters.

1. *Volatile fulphureous acid*. This is feldom found, both becaufe it eafily lofes its phlogifton, and becaufe it muft almoft always meet with fome fubftance that it is capable of diffolving.

2. *Sulphur*. This is found fometimes fingly, but generally in form of a liver of fulphur. In thefe waters, fulphur is formed into a hepar by means of calcareous earth or of mineral alkali.

3. *Vitriolic falts with earthy bafes*. Thefe falts are frequently *felenitic*, that is, their acid is combined with a calcareous earth; or they are of the nature of Epfom falt, the bafis of which is magnefia. Sometimes, but not fo frequently, they are *aluminous*, when their acid happens to be united with an argillaceous earth.

4. *Vitriols*. *Martial vitriol* is frequently contained in mineral waters; *vitriol of copper* is fometimes, but feldom, and *vitriol of zinc* is ftill more rarely found in thefe waters. The vitriols of other metallic fubftances are fcarcely ever, but in very fingular cafes, found in water.

5. Laftly, *vitriolic falts with bafis of fixed alkali*. This is always *Glauber's falt*. Neither *vitriolated tartar* nor *vitriolic ammoniacal falt* are ever found, unlefs by fome fingular accident, in mineral waters.

The combinations of marine acid that are contained in mineral waters are *common falt*, and *marine falt with earthy bafis*. For no combinations of this acid with phlogifton are known, and it is very feldom found united with any metallic fubftance.

Compounds formed of the nitrous acid with an earthy bafis are very common in waters in this country, infomuch that fome have thought that nitre might be extracted from them advantageoufly in the way of trade. See Chemistry, n° 178. In France, however, the cafe feems to be otherwife; for Mr Macquer determines, in his Chemical Dictionary, that the nitrous acid is not (nay that it *cannot*) be found in waters except by accident.

Thefe are the principal fubftances that form almoft all thefe waters. We fhall now fhew the proofs by means of which they may be difcovered in water, without decompofing the water by evaporation or by diftillation.

If any portion of difengaged acid or alkali be contained in water, it may be known by the tafte, by changing the colour of violets or of turnfol, and by adding the precife quantity of acid or of alkali that is neceffary for the faturation of the contained difengaged faline matter.

Sulphur, and liver of fulphur, may be difcovered in waters by their fingular fmell, and by the black colour which thefe fubftances give to white metals or to their precipitates, but efpecially to filver.

Vitriolic falts with earthy bafis may be difcovered in water by two proofs: 1. By adding fome fixed alkali, which decompofes all thefe falts, and precipitates their earthy bafis; and, 2. By adding a folution of mercury in nitrous acid, which alfo decompofes thefe falts, and forms a *turbith mineral* with their acid. But for this purpofe the folution of mercury ought to have a fuperabundant quantity of acid: for this folution, when perfectly faturated, forms a precipitate with any kind of water, as M. Rouelle has very juftly remarked; and indeed, all metallic folutions in any acids are ftrictly capable of decompofition by water alone, and fo much more eafily as the acid is more perfectly faturated with the metal.

Martial vitriol or iron combined with any acid, or even with gas, fhews itfelf in waters by blackening an infufion of galls, or by forming a Pruffian blue with the phlogifticated alkaline lixivium.

The vitriol of copper, or copper diffolved by any acid, may be difcovered by adding fome of the vola-

Mineral. tile ſpirit of ſal ammoniac, which produces a fine blue colour; or by the addition of clean iron, upon the ſurface of which the copper is precipitated in its natural or metallic ſtate.

Glauber's ſalt is diſcovered by adding a ſolution of mercury in nitrous acid, and forming with it a turbith mineral; or by cryſtallization.

Common ſalt contained in waters forms with a ſolution of ſilver in nitrous acid a white precipitate, or luna cornea. It may alſo be known by its cryſtallization. Marine ſalt with earthy baſis produces the ſame effect upon ſolution of ſilver. It alſo forms a precipitate when fixed alkali is added. The acrimony, bitterneſs, and deliqueſcency of this ſalt, ſerve to diſtinguiſh it.

The proofs related for the examination of mineral waters, are only thoſe which are moſt eſſential. Many others may be made to confirm the former proofs: but the details of theſe are too extenſive to be inſerted here. We ſhall add only two of theſe, becauſe they are very general, and may be very uſeful.

The firſt is the production of artificial ſulphur, or of the volatile ſulphureous acid; by which means the vitriolic acid may be diſcovered in any combination whatever. For this purpoſe, the matter to be examined muſt be mixed with any inflammable ſubſtance, and expoſed to a red heat. If this matter contained but a particle of vitriolic acid, it would be rendered ſenſible by the ſulphur, or by the volatile ſulphureous acid thence produced.

The ſecond general proof for mineral waters which we ſhall mention here, ſerves to diſcover any metallic ſubſtance whatever, diſſolved in water by any acid. This proof conſiſts in adding ſome of the liquor ſaturated by the colouring matter of Pruſſian blue, deſcribed under the article CHEMISTRY, n° 391. This liquor produces no effects upon any neutral ſalts with earthy or alkaline baſes, but decompoſes all metallic ſalts: ſo that if no precipitate be formed upon adding ſome of this liquor, we may be certain that the water does not contain any metallic ſalt; and on the contrary, if a precipitate be formed, we may certainly infer that the water does contain ſome metallic ſalt.

Two kinds only of gas, or the ſpirituous volatile part of ſome waters, are hitherto known; of which one is the volatile ſulphureous acid, and the other is fixed air, See AIR, FIXED *Air*, and GAS, *paſſim*. Air united ſuperabundantly with ſpirituous waters is the chief cauſe of their lightneſs, piquancy, and ſparkling.

When the nature and quantities of the principles contained in a mineral water are aſcertained by ſuitable experiments, we may imitate artificially this water, by adding to pure water the ſame proportions of the ſame ſubſtances, as Mr Venel has done in examining ſeveral waters, eſpecially that of Selters.

We may eaſily perceive the neceſſity of uſing no veſſels in theſe experiments, but ſuch as are perfectly clean and rinſed with diſtilled water; of weighing the products of the experiments very exactly; of making the experiments upon as large quantities of water as is poſſible, eſpecially the evaporations, cryſtallizations, and diſtillations; and of repeating all experiments ſeveral times. We may further obſerve, that the mixtures from which any precipitates might be expected ought to be kept two or three days, becauſe many of theſe precipitates require that time, or more, to appear, or to be entirely depoſited.

MINERALOGY,

1 IS that ſcience which teaches us the properties of mineral bodies, and by which we learn how to characteriſe, diſtinguiſh, and claſs them into a proper order.

2 Mineralogy ſeems to have been in a manner coeval with the world. Precious ſtones of various kinds appear to have been well known among the Jews and Egyptians in the time of Moſes; and even the moſt rude and barbarous nations appear to have had ſome knowledge of the ores of different metals. As the ſcience is nearly allied to chemiſtry, it is probable that the improvements both in chemiſtry and mineralogy have nearly kept pace with each other; and indeed it is but of late, ſince the principles of chemiſtry were well underſtood, that mineralogy hath been advanced to any degree of perfection. The beſt way of ſtudying mineralogy, therefore, is by applying chemiſtry to it; and not contenting ourſelves merely with inſpecting the outſides of bodies, but decompounding them according to the rules of chemiſtry. This method hath been brought to the greateſt perfection by Mr Pott of Berlin, and after him by Mr Cronſtedt of Sweden. To obtain this end, chemical experiments in the large way are without doubt neceſſary; but as a great deal of the mineral kingdom has already been examined in this manner, we do not need to repeat all thoſe experiments in their whole extent, unleſs ſome new and particular phenomena ſhould diſcover themſelves in thoſe things we are examining; elſe the tedioufneſs of thoſe proceſſes might diſcourage ſome from going farther, and take up much of the time of others that might be better employed. An eaſier way may therefore be adopted, which even for the moſt part is ſufficient, and which though made in miniature, yet is as ſcientifical as the common manner of proceeding in the laboratories, ſince it imitates that, and is founded upon the ſame principles. This conſiſts in making the experiments upon a piece of charcoal with the concentrated flame of a candle blown through a blow-pipe. The heat occaſioned by this is very intenſe; and the mineral bodies may here be burnt, calcined, melted, and ſcorified, &c. as well as in any great works.

A pocket-laboratory containing all things neceſſary for trying mineralogical experiments is repreſented, Plate CLXXXI. fig. 1. with the caſe, exactly of the form, bigneſs, and proportions as that made uſe of by Mr Cronſtedt: what alterations there may be wanted are eaſily found out by practice. 3

c, *h*. Are the two parts of which the BLOW-*Pipe* conſiſts, and which are already deſcribed under that article.

a. A wax-candle, deſtined to be made uſe of, particularly in travelling, when no other candle is to be had.

b. A

Fig. 1.

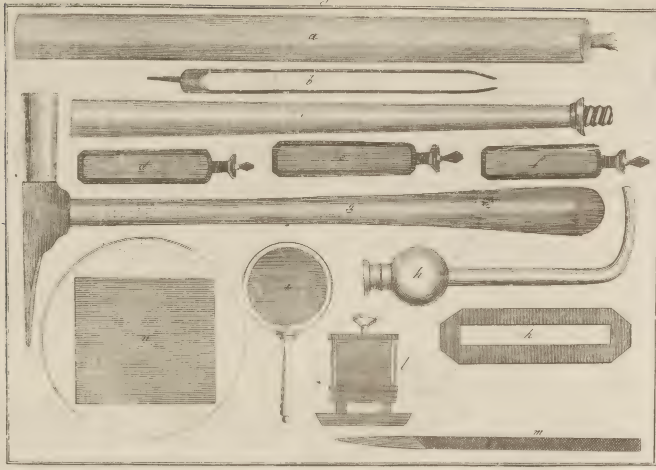


Fig. 2.

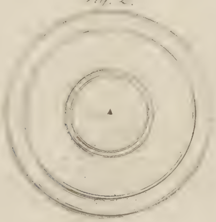


Fig. 3.

Fig. 4.

Fig. 5. Trough.

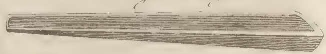
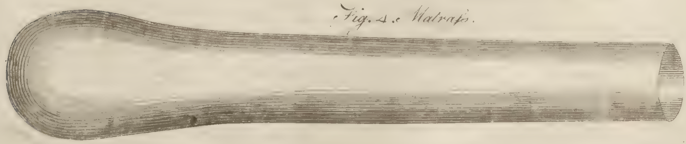


Fig. 4. Matrass.



A. Bell Sculp.

Method of making Experiments.

b. A pair of nippers, to handle ſo much the eaſier theſe things which are to be tried, becauſe they are generally ſmall particles: this ſerves alſo to touch and turn the ſubjects during the experiments, when they are hot and could not be well handled with the fingers.

d, *e*, *f*. Are three phials, to put the required fluxes in, viz. borax, the mineral alcali *ſal ſodæ*), and ſal fuſibile microcoſmicum.

g. A hammer, to break any part of a ſtone, when it is to be tried: this ſerves alſo to pound things with.

i. A magniſying-glaſs, neceſſary when the objects are too ſmall to be ſeen by the naked eye.

k. A ſteel to ſtrike fire, by which the hardneſs or ſoftneſs of the bodies is tried.

l. A loadſtone, to diſcover the preſence of iron.

m. A file, wherewith to diſtinguiſh natural gems, quartz-cryſtals, and artificial or coloured glaſſes, from one another.

n. A thin ſquare plate made of untempered ſteel, filed flat on one ſide to pound things upon, and poliſhed on the other ſide to hammer metals upon.

Above this ſteel plate *n*, and within the circle drawn round about it, is the place for a candleſtick. This candleſtick is ſhewn in plan, fig. 2. and in profile, fig. 3. It conſiſts of a round braſs plate; the point *a*, and the ring *b* round it, is inſtead of the ſocket in another candleſtick, which would here take up too much room.

Fig. 4. is a thin iron ring, a ſixth part of an inch high; within this ring the pounding and grinding of the things upon the ſteel plate, fig. 1. *n*, is performed, that they may not be loſt. In packing up, this ring is to be put looſe upon the candleſtick; and, as it is lower than the point of this, it does not take up much room in the caſe.

The whole caſe thus made, with all the inſtruments in it, is no more than one and an eighth part of an inch high, and conſequently not more troubleſome to be carried in the pocket than a ſmall book.

The pocket-laboratory here deſcribed, and the box for the acids, to be afterwards mentioned have been improved after the manner of Mr Cronſtedt, by a gentleman particularly acquainted with Mr Engeſtrom, from whom he learned this method of making mineralogical experiments. The bulk of the firſt has been reduced nine and a half cubic inches; its length being diminiſhed one ſixteenth of an inch, the breadth five and the depth two; notwithſtanding which, there is alſo added a piece of charcoal for trying the experiments, a flint, a piece of agaric tinder, and ſome matches for lighting the candle. The three phials *n m v* for the ſalts, are of different colours, to prevent any miſtake. The candleſtick has different concentric grooves for keeping the reſults of the trials ſeparate. The blow-pipe *e h* has a ſilver mouth-piece, and ſcrews in the middle of the ball, in order to clean out the moiſture with the greater eaſe; and the ſmall wire (Plate CLV. fig. 2. n° 1.) is more conveniently detached than fixed round it. The other box for the acids is reduced to leſs than a fourth of its original bulk, being exactly of the ſame ſize with the above. It contains two ſmall matraſſes (fig. 4.) for making ſolutions; a trough (fig. 5.) for waſhing the ore after its being pounded; and the three ſmall bottles with double ſtoppers, for the nitrous, muriatic, and vitriolic acids, have their reſpective initials cut on each.

Method of making Experiments.

Both theſe pocket-laboratories, made in the neateſt manner by an ingenious artiſt, may be had ready furniſhed with the pureſt acids, &c. at the General Office of Buſineſs, Arts, and Trade, N° 98. Wood-ſtreet, Cheapſide.

Whenever any thing is to be tried, one muſt not 4
begin immediately with the blow-pipe; ſome preliminary experiments ought to go before, by which thoſe in the fire may afterwards be directed. For inſtance, a ſtone is not always homogeneous, or of the ſame kind throughout, although it may appear to the eye to be ſo: the magniſying-glaſs is therefore neceſſary, to diſcover the heterogeneous particles, if there be any; and theſe ought to be ſeparated, and every thing tried by itſelf, that the effects of two different things, tried together, may not be attributed to one alone. This might happen with ſome of the finer micæ, which are now and then found mixed with ſmall particles of quartz, ſcarcely to be perceived by the eye. The trapp (in German *ſchwartzſtein*) is alſo ſometimes mixed with very fine particles of feltſpat (*ſpatum ſcintillans*), or of calcareous ſpar, &c. After this experiment follows that to try the hardneſs of the ſtone in queſtion with the ſteel. The flint and garnet kinds are commonly known to ſtrike fire with the ſteel; but there are alſo other ſtones, though very ſeldom, found ſo hard as to ſtrike fire: a kind of trapp is found of that hardneſs in which no particles of feltſpat are to be ſeen. Coloured glaſſes reſemble true gems; but as they are very ſoft in compariſon to theſe, they are eaſily diſcovered by means of the file: the common quartz-cryſtals are harder than coloured glaſſes, but ſofter than the gems. The loadſtone diſcovers the preſence of iron, when it is not mixed in too ſmall a quantity in the ſtone, and often before the ſtone is roaſted. Some kinds of hæmatites, and particularly the cœruleſcens, is very like ſome other iron ores; but diſtinguiſhes itſelf from theſe by a red colour when pounded, and others giving a blackiſh powder, and ſo forth.

To manage the blow-pipe with eaſe requires ſome 5
practice. A beginner blows generally too ſtrongly, which forces him to take breath very often, and then he draws the flame at the ſame time along into the blow-pipe: this is troubleſome for himſelf, and the experiment cools always a little at the ſame time. But the more experienced can breathe in through the noſe, and yet at the ſame time blow through the pipe, whereby a conſtant flame from the candle is kept up. The whole art conſiſts in conſtantly taking in air through the noſe, and with the tongue moderating its blowing out; ſo that the tongue performs nearly the office of a ſucker in a pump; or rather, the action of the noſe, lungs, and mouth, reſembles here the action of bellows with double partitions. In this manner there is no need of blowing violently, but only with a moderate and equal force; and thus the breath can never fail the operator. The only inconveniency attending it is, that the lips grow weak or tired, after having continued to blow for a while in one ſtrain; but they ſoon recover their former ſtrength by ceaſing to blow for ſome minutes.

The

Method of making Experiments.

6 The candle uſed for this purpoſe ought to be ſnuffed often, but ſo that the top of the wick may retain ſome fat in it, becauſe the flame is not hot enough when the wick is almoſt burnt to aſhes; ſo that only the top muſt be ſnuffed off, becauſe a low wick gives too ſmall a flame. The blue flame is the hotteſt; this ought therefore to be forced out when a great heat is required, and only the point of the flame muſt be directed upon the ſubject which is to be eſſayed.

7 The piece of charcoal made uſe of in theſe experiments muſt not be of a diſpoſition to crack. If this ſhould happen, it muſt gradually be heated until it does not crack any more, before any eſſay is made upon it. If this be not obſerved, but the eſſay made immediately with a ſtrong flame, ſmall pieces of it will ſplit off in the face and eyes of the eſſayer, and often throw along with them the matter that was to be eſſayed. Charcoal which is too much burnt conſumes too quickly during the experiment, leaving ſmall holes in it, wherein the matter to be tried may be loſt: and charcoal that is burnt too little catches flame from the candle, burning by itſelf like a piece of wood, which likewiſe hinders the proceſs.

8 Of thoſe things that are to be eſſayed, only a ſmall piece muſt be broke off for that purpoſe, not bigger than that the flame of the candle may be able to act upon it at once, if required; which is ſometimes neceſſary; for inſtance, when the matter requires to be made red-hot throughout. A piece of about an eighth part of an inch ſquare is reckoned of a moderate ſize, and fitteſt for experiments; ſeldom more, but rather leſs. This proportion is only mentioned as a direction in regard to the quantity, the figure being of no conſequence at all, a piece broke off from a ſtone ſeldom or never happening to be ſquare. But here it is to be obſerved, that the piece ought to be broke as thin as poſſible, at leaſt the edges: the advantage thereof is eaſily ſeen, the fire having then more influence upon the ſubject, and the experiment being quicker made. This is particularly neceſſary to be obſerved when ſuch ſtones are to be eſſayed, which, although in ſome reſpects fuſible by themſelves, yet reſiſt conſiderably the action of the fire; becauſe they may by theſe means be brought into fuſion, at leaſt at their edges, which elſe would have been very difficult if the piece had been thick.

9 Some of the mineral bodies are very difficult to keep ſteady upon the charcoal during the experiment, before they are made red-hot; becauſe, as ſoon as the flame begins to act upon them, they ſplit aſunder with violence, and diſperſe. Such often are thoſe which are of a ſoft conſiſtence, or a particular figure, and which preſerve the ſame figure in however minute particles they are broke; for inſtance, the calcareous ſpar, the ſparry gypſum, ſparry fluor, white ſparry lead-ore, the potters ore, *(galena teſſellata)*, the teſſellated mock-lead or blende, &c. even all the common fluors which have no determinate figure, and moſt of the *mineræ metallorum calciformes cryſtalliſatæ* or *ſpatoſæ:* all theſe are not ſo compact as common hard ſtones; and therefore, when the flame is immediately puſhed at them, the heat forces itſelf quickly through and into their clefts or pores, and cauſes this violent expanſion and diſperſion. Many of the clays are likewiſe apt to crack in the fire, which may be for the moſt part aſcribed to the humidity, of which they always retain a portion. Beſides thoſe enumerated, there may be found now and then other mineral bodies of the ſame quality.

Method of making Experiments.

The only way of preventing this inconveniency, is to heat the body as ſlowly as poſſible. It is beſt firſt of all to heat that place of the charcoal where the piece is intended to be put on, and afterwards lay it thereon; a little crackling will then enſue, but commonly of no great conſequence. After that, the flame is to be blown very ſlowly towards it, in the beginning not directly upon, but ſomewhat above it, and ſo approaching nearer and nearer with the flame until it becomes red-hot. This will do for the moſt part; but there are nevertheleſs ſome ſubſtances which, notwithſtanding all theſe precautions, it is almoſt impoſſible to keep on the charcoal. Thus the fluors are generally the moſt difficult; and as one of their principal characters is diſcovered by their effects in the fire *per ſe*, they ought neceſſarily to be tried that way. To this purpoſe it is beſt to make a little hole in the charcoal to put the fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a ſmall opening for the flame to come in at, and to look at the proof. As this ſtone will nevertheleſs moſtly ſplit and fly about, a larger piece thereof than is beforementioned muſt be taken, in order to have at leaſt ſomething of it left.

10 But if the experiment is to be made upon a ſtone whoſe effects one does not want to ſee in the fire *per ſe*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, when always ſome part of it will remain in the borax, notwithſtanding the greateſt part may ſometimes fly away by cracking.

11 As the ſtones undergo great alterations when expoſed to the fire by themſelves, whereby ſome of their characteriſtics, and often the moſt principal, are diſcovered, they ought firſt to be tried that way; obſerving what has been ſaid before concerning the quantity of the matter, direction of the fire, &c. The following effects are generally the reſults of this experiment, *viz.*

12 1. Calcareous earth or ſtone, when it is pure, does never melt by itſelf, but becomes white and friable, ſo as to break freely between the fingers; and, if ſuffered to cool, and then mixed with water, it becomes hot, juſt as common quick-lime. As in theſe experiments only very ſmall pieces are uſed, this laſt effect is beſt diſcovered by putting the proof on the outſide of the hand, with a drop of water to it, when inſtantly a very quick heat is felt on the ſkin. When the calcareous ſubſtance is mixed with the vitriolic acid, as in the gypſum; or with clay, as in the marle; it commonly melts by itſelf; yet more or leſs difficultly in proportion to the differences of the mixtures: the gypſum produces generally a white, and the marle a grey glaſs or ſlag. When there is any iron in it, as in white iron ore, it becames dark, and ſometimes quite black, &c.

13 2. The ſiliceæ never melt alone, but become generally more brittle after being burnt: ſuch of them as are coloured become colourleſs, and the ſooner when it does not ariſe from any contained metal; for inſtance, the topazes, amethiſts, &c. ſome of the precious ſtones, however, excepted. And ſuch as are mixed with a quantity of iron grow dark in the fire, as ſome of the jaſpers, &c.

3. The

Method of making Experiments.

3. The garnet-kind melt always into a dark ſlag; and ſometimes ſo eaſily, that it may be brought into a round globule upon the charcoal.

14 4. The argillaceæ, when pure, never melt, but be-
15 come white and hard: the ſame effects follow when they are mixed with phlogiſton: for inſtance, the ſoap-rock is eaſily cut with the knife; but, being burnt, it cuts glaſs, and would ſtrike fire with the ſteel, if as large a piece as is neceſſary for that purpoſe could be tried in this way. The ſoap-rocks are ſometimes found of a dark brown and nearly black colour, but become white in the fire, as a piece of China ware: however, care muſt be taken not to puſh the flame from the top of the wick, there being for the moſt part a ſooty ſmoke, which commonly will darken all that it touches; and if this is not obſerved, a miſtake in the experiment might eaſily happen: but if it is mixed with iron, as it is ſometimes found, it does not ſo eaſily part with its dark colour. The argillaceæ, when mixed with lime, melt by themſelves, as above-mentioned. When mixed with iron, as in the boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark ſlag: the ſame happens when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

16 5. The micaceæ and aſbeſtinæ become ſomewhat hard and brittle in the fire, and are more or leſs refractory, though they give ſome marks of fuſibility.

17 6. The fluors diſcover one of their chief characteriſtics by giving a light, like phoſphorus, in the dark, when they are ſlowly heated; but loſe this property, as well as their colour, as ſoon as they are made red-hot: they commonly melt in the fire into a white opaque ſlag, though ſome of them not very eaſily.

18 7. Some ſorts of the zeolites, a ſtone lately diſcovered, melt eaſily and foam in the fire, ſometimes nearly as much as borax, and become a frothy ſlag, &c.

19 8. A great many of thoſe mineral bodies which are impregnated with iron, as the boles, and ſome of the white iron ores, &c. as well as ſome of the other iron ores, *viz.* the bloodſtone, are not attracted by the loadſtone before they have been thoroughly roaſted, &c.

20 After the mineral bodies have been tried in the fire by themſelves, they ought to be melted with fluxes, to find out if they can be diſſolved or not, and ſome other phenomena attending this operation. To this purpoſe three different kinds of ſalts are uſed as fluxes, viz. *ſal ſodæ*, *borax*, and *ſal fuſibile microcoſmicum*.

21 The ſal ſodæ is not much uſed in theſe ſmall experiments, its effects upon the charcoal rendering it for the moſt part improper; becauſe, as ſoon as the flame begins to act upon it, it melts inſtantly, and is almoſt wholly attracted by the charcoal. When this ſalt is employed to make any experiment, but a very little quantity thereof is wanted at once, *viz.* about the cubical contents of an eighth part of an inch, more or leſs: this is laid upon the charcoal, and the flame blown on it with the blow-pipe; but as this ſalt commonly is in form of a powder, it is neceſſary to go on very ſoftly, that the force of the flame may not diſperſe the minute particles of the ſalt. As ſoon as it begins to melt, it runs along on the charcoal almoſt as melted tallow; and when cold, it is a glaſſy matter of an opaque dull colour ſpread on the coal. The moment it is melted, the matter which is to be tried ought to be put into it, becauſe otherwiſe the greateſt part of the ſalt will be ſoaked into the charcoal, and too little of it left for the intended purpoſe: the flame ought then to be directed on the matter itſelf, and if the ſalt ſpreads too much about, leaving the proof almoſt alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the ſubject of the experiment. In the eſſays made with this ſalt, it is true, we may find if the mineral bodies which are melted with it have been diſſoved by it or not; but we cannot tell with any certainty whether this is done haſtily and with force, or gently and ſlowly; whether only a leſs or a greater part of the matter has been diſſolved; nor can it be well diſtinguiſhed if the matter has imparted any weak tincture to the ſlag; becauſe this ſalt always bubbles upon the charcoal during the experiment, nor is it clear when cool; ſo that ſcarce any colour, except it be a very deep one, can be diſcovered, although it may ſometimes be coloured by the matter that has been tried.

The two other ſalts, *viz.* the *borax*, and the *ſal fuſibile microcoſmicum*, are very well adapted to theſe ex- 22
periments, becauſe they may by the flame be brought to a clear uncoloured and tranſparent glaſs; and as they have no attraction to the charcoal, they keep themſelves always upon it in a round globular form. The *ſal fuſibile microcoſmicum* is very ſcarce, and not to be met with in the ſhops; it is made of urine. For its preparation, ſee CHEMISTRY, n° 308.

The quantity of theſe two ſalts required for an ex- 23
periment is almoſt the ſame as the ſal ſodæ; but as theſe ſalts are cryſtalliſed, and conſequently include a great deal of water, particularly the borax, their bulk is conſiderably reduced when melted, and therefore little more may be taken than the before-mentioned quantity.

The borax and microcoſmic ſalt, when expoſed to the 24
flame of the blow-pipe, bubble very much and foam before they melt to a clear glaſs; but more ſo the borax, which for the moſt part depends on the water they contain: and as this would hinder the eſſayer to make due obſervations on the phenomena of the experiment, the ſalt which is to be uſed muſt firſt be brought to clear glaſs before it can ſerve as a flux; it muſt therefore be kept in the fire until it is become ſo tranſparent that the cracks in the charcoal may be ſeen thro' it. This done, whatſoever is to be tried, is put to it, and the fire continued.

Here it is to be obſerved, that for the eſſays made 25
with any of theſe two fluxes on mineral bodies, no larger pieces of theſe muſt be taken than that all together they may keep a globular form upon the charcoal; becauſe then it may be better diſtinguiſhed in what manner the flux acts upon the matter during the experiment: if this is not obſerved, the flux, communicating itſelf with every point of the ſurface of the mineral body, ſpreads all over it, and keeps the form of this laſt, which commonly is flat, and by that means hinders the operator to obſerve all the phenomena which may happen. Beſides, the flux being in too ſmall a quantity, in proportion to the body to be tried, is too weak to act with all its force upon it. The beſt proportion, therefore, is about a third part of the mineral body to the flux. And, as the quantity of the flux (21, 23) makes a globe of a due ſize, in regard to the greateſt

Method of making Experiments.

greateſt heat that it is poſſible to procure in theſe experiments, the ſize of the mineral body (8) required when it is to be tried in the fire by itſelf, is too large on this occaſion, the third part of it being here almoſt ſufficient.

26 The ſal ſodæ, as has been ſaid before, is not of much uſe in theſe experiments; nor has it any particular qualities in preference to the two laſt-mentioned ſalts, except that it diſſolves the zeolites eaſier than the borax and the *ſal fuſibile microcoſmicum*.

This laſt-mentioned ſalt ſhews almoſt the ſame effects in the fire as the borax; and differs from this in very few circumſtances, of which one of the principal is, that, when melted with mangaueſe, it becomes of a crimſon hue, inſtead of a jacinth colour, which borax takes.

This ſalt is, however, for its ſcarcity, ſtill very little in uſe, borax alone being that which is commonly uſed. Whenever a mineral body is melted with any of theſe two laſt mentioned ſalts, in the above-deſcribed manner, it is eaſily ſeen whether it is quickly diſſolved; becauſe in that caſe an effervefcence ariſes, which laſts till the whole is diſſolved; or whether this is ſlowly done, in which caſe few and ſmall bubbles only riſe from the matter: likewiſe, if it cannot be diſſolved at all; becauſe then it is obſerved only to turn round in the flux without the leaſt bubble, and the edges look as ſharp as they were before.

27 In order further to illuſtrate what has been ſaid about theſe experiments, we ſhall mention ſome inſtances concerning the effects of borax upon the mineral bodies, *viz.*

28 1. The calcareous ſubſtances, and all thoſe ſtones which contain any thing of lime in their compoſition, diſſolve readily, and with effervefcence, in the borax: this effervefcence is the more violent, the greater the portion of lime contained in the ſtone. This, however, is not the only reaſon in the gypſum, becauſe both the conſtituents of this do readily mix with the borax, and therefore a greater effervefcence ariſes in melting gypſum with the borax than lime alone.

29 2. The ſiliceæ do not diſſolve, unleſs ſome few, which contain a quantity of iron.

30 3. The argillaceæ, when pure, are not acted upon by the borax; but when they are mixed with ſome heterogeneous bodies, they are diſſolved, though very ſlowly; ſuch is, for inſtance, the ſtone marrow, the common clay, &c.

31 4. The granateæ, zeolites, and trapp, diſſolve but ſlowly.

32 5. The fluores, aſbeſtinæ, and micaceæ, diſſolve for the moſt part very eaſily; and ſo forth.

33 Some of theſe bodies melt to a colourleſs tranſparent glaſs with the borax; for inſtance, the calcareous ſubſtances when pure, the fluors, ſome of the zeolites, &c. Others tinge the borax with a green tranſparent colour; *viz.* the granateæ, trapp, ſome of the argillaceæ, ſome of the micaceæ and aſbeſtinæ: this green has its origin, partly from a ſmall portion of iron which the granateæ particularly contain, and partly from phlogiſton.

34 The borax cannot diſſolve but a certain quantity of a mineral body proportional to its own. Of the calcareous kind it diſſolves a vaſt quantity; but turns at laſt, when too much has been added, from a clear, tranſparent, to a white opaque ſlag. When the quantity of the calcareous matter exceeds but little in proportion, the glaſs looks very clear as long as it remains hot; but as ſoon as it begins to cool, a white half opaque cloud is ſeen to ariſe from the bottom, which ſpreads over the third, half, or more of the glaſs globe, in proportion to the quantity of calcareous matter; but the glaſs or ſlag is nevertheleſs ſhining, and of a glaſſy texture when broke: if more of this matter be added, the cloud riſes quicker and more opaque, and ſo by degrees till the ſlag becomes quite milk-white: it is then no more of a ſhining, but rather dry appearance, on the ſurface; is very brittle, and of a grained texture when broke.

All that has been ſaid hitherto of experiments upon mineral bodies, is only concerning the ſtones and earths. We now proceed to the metals and ores, in order to deſcribe the manner of examining theſe bodies, and particularly the management of the blowpipe in theſe experiments. An exact knowledge and nice proceeding are ſo much the more neceſſary here, as the metals are often ſo much digniſed in their ores as to be very difficultly known by their external appearance, and liable ſometimes to be miſtaken one for the other: ſome of the cobalt ores, for inſtance, reſemble much a pyrites arſenicalis; there are alſo ſome iron and lead ores which are nearly like one another, &c. 35

As the ores generally conſiſt of metals mineraliſed with ſulphur or arſenic, or ſometimes both together; they ought firſt to be expoſed to the fire by themſelves in order not only to determine with which of them they are mineraliſed, but alſo to ſet them free from theſe volatile mineraliſing bodies: And this alſo ſerves inſtead of calcination, by which they are prepared for further eſſays. 36

Here it muſt be obſerved, that, whenever any metal or fuſible ore is to be tried, a little concavity muſt be made in that place of the charcoal where the matter is to be put; becauſe, as ſoon as it is melted, it forms itſelf into a globular figure, and might then roll from the charcoal, if its ſurface was plain; but when borax is put to it, this inconveniency is not ſo much to be feared. 37

Whenever an ore is to be tried, a ſmall bit is broke off for that purpoſe, of ſuch a ſize as has been directed; this bit is laid upon the charcoal, and the flame blown on it ſlowly: Then the ſulphur or arſenic begins to part from it in form of ſmoke; theſe are eaſily diſtinguiſhed from one another by their ſmell, that of ſulphur being ſufficiently known, and the arſenic ſmelling like garlic. The flame ought to be blown very ſoftly, as long as any ſmoke is ſeen to ariſe from the ore; but after that the heat muſt be augmented by degrees, in order to make the calcination as perfect as poſſible. If the heat is applied very ſtrong from the beginning upon an ore that contains much of the ſulphur or arſenic, this ore will preſently melt, and yet loſe very little of its mineraliſing bodies, and by that means render the calcination very imperfect. It is, however, impoſſible to calcine the ores in this manner to the utmoſt perfection, which is eaſily ſeen in the following inſtance, viz. in melting down a calcined potter's ore with borax, it will be found to bubble upon the coal, which depends on the 38

ſulphur

sulphur which is still left, the vitriolic acid of this uniting with the borax, and causing this motion. However, lead, in its metallic form, melted in this manner, bubbles alone upon the charcoal, if any sulphur remains in it. But as the lead, as well as some of the other metals, may raise bubbles upon the charcoal, although they are quite free from the sulphur, only by the flame's being forced too violently on it, these phænomena ought not to be confounded with each other.

39 The ores being thus calcined, the metals contained in them may be discovered, either by being melted alone, or with fluxes: when they shew themselves either in their pure metallic state, or by tinging the flag with colours peculiar to each of them. In these experiments, it is not to be expected that the quantity of metal contained in the ore should be exactly determined; this must be done in larger laboratories. This cannot, however, be looked upon as any defect, since it is sufficient for a mineralogist only to find out what sort of metal is contained in the ore. There is another circumstance which is a more real defect in our little laboratory, which is, that some ores are not at all able to be tried in it by so small an apparatus: for instance, the gold ore called *pyrites aureus*, which consists of gold, iron, and sulphur. The greatest quantity of gold which this ore contains is about one ounce, or one ounce and an half, out of 100 pounds of the ore, the rest being iron and sulphur; and as only a very small bit is allowed for these experiments, the gold contained therein can hardly be discerned by the eye, even if it could be extracted; but it goes along with the iron in the flag, this last metal being in so large a quantity in proportion to the other, and both of them being capable of mixture with each other.

All the kinds of blende, black-jack, which are mineralised zinc ores, containing zinc, sulphur, and iron, cannot be tried this way, because they cannot be perfectly calcined; and besides, the zinc flies off, when the iron scorifies: neither can all those blendes which contain silver or gold mineralised with them, be tried in this manner, which is particularly owing to the imperfect calcination: nor are the quicksilver ores fit for these experiments; the volatility of this semi-metal making it impossible to bring it out of the poorer sort of ores; and the rich ores which sweat out the quicksilver, when kept close in the hand, not wanting any of these essays, &c. Those ores ought to be essayed in larger quantities, and by methods which cannot be applied upon a piece of charcoal.

40 Some of the rich silver ores are easily tried: for instance, *minera argenti vitrea*, commonly called *silver-glass*, which consists only of silver and sulphur. When this ore is exposed to the flame, it melts instantly, and the sulphur goes away in fume, leaving the silver pure upon the charcoal, in a globular form. If this silver should happen to be of a dirty appearance, which often is the case, then it must be melted anew with a very little borax; and after it has been kept in fusion for a minute or two, so as to be perfectly melted and red-hot, the proof is suffered to cool: it may then be taken off the coal, and being laid upon the steel-plate, the silver is separated from the flag by one or two strokes of the hammer. Here the use of the iron ring is manifest; for this ought first to be placed upon the plate, to hinder the proof from flying off by the violence of the stroke, which otherwise would happen. The silver is then found inclosed in the flag of a globular form, and quite shining, as if it were polished. When a large quantity of silver is contained in a lead ore, viz. in a potter's ore, it can likewise be discovered through the use of the blow-pipe.

Of the pure tin ores, the tin may be melted out in its metallic state. Some of these ores melt very easily, and yield their metal in quantity, if only exposed to the fire by themselves: but others are more refractory, and as these melt very slowly, the tin, which sweats out in form of very small globules, is instantly burnt to ashes, before these globules have time to unite in order to compose a larger globe which might be seen by the eye, and is not so soon destroyed by the fire; it is therefore necessary to add a little borax to these from the beginning, and then to blow the flame violently at the proof. The borax does here preserve the metal from being too soon calcined; and even contributes to the readier collecting of the small metallic particles, which soon are seen to form themselves into a globule of metallic tin at the bottom of the whole mass, nearest to the charcoal. As soon as so much of metallic tin is produced as is sufficient to convince the operator of its presence, the fire ought to cease, although not the whole of the ore be yet melted; because seldom, or rather never, the whole of this kind of ore can be reduced into metal by means of these experiments, a great deal thereof always being calcined: and if the fire is continued too long, perhaps even the metal, already reduced, may likewise be burnt to ashes; for the tin is very soon calcined by the fire. 41

Most part of the lead ores may be brought to a metallic lead upon the charcoal. The *mineræ plumbi calciformes*, which are pure, are easily melted into lead: but such of them as are mixed with an *ochra ferri*, or any kind of earth, as clay, lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined therewith in any large quantity: this happens even with the *minera plumbi calciformis arsenica mixta*. These, therefore, are not to be tried but in larger laboratories. However, every mineral body suspected to contain any metallic substance, may be tried by the blow-pipe, so as to give sufficient proofs whether it contains or not, by its effects being different from those of the stone or earths, &c. 42

The *mineræ plumbi mineralisatæ* leave the lead in a metallic form, if too large a quantity of iron be not mixed with it. For example, when a tessellated or steel-grained lead-ore is exposed to the flame, its sulphur, and even the arsenic, if there be any, begins to fume, and the ore itself immediately to melt into a globular form; the rest of the sulphur continues then to fly off, if the flame is blown slowly upon the mass; instead of that, very little of the sulphur will go off, if the flame is forced violently on it: in this case, it rather happens that the lead itself crackles and dissipates, throwing about very minute metallic particles. 43

Of Experiments. The sulphur being driven out as much as possible, which is known by finding no sulphureous vapour in smelling at the proof, the whole is suffered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead ore, the lead which is melted out of it is not of a metallic shining, but rather of a black and uneven surface: a little borax must in this case be melted with it, and as soon as no bubble is seen to rise any longer from the metal into the borax, the fire must be discontinued: when the mass is grown cold, the iron will be found scorified with the borax, and the lead left pure and of a shining colour.

44 The borax does not scorify the lead in these small experiments, when it is pure: if the flame is forced with violence on it, a bubbling will ensue, resembling that which is observed when borax dissolves a body melted with it; but when the fire ceases, the slag will be perfectly clear and transparent, and a quantity of very minute lead particles will be seen spread about in the borax, which have been torn off from the mass during the bubbling.

45 If such a lead ore is rich in silver, this last metal may likewise be discovered by this experiment; because, as the lead is volatile, it may be forced off, and the silver remain. To effect this, the lead, which is melted out of the ore, must be kept in constant fusion with a slow heat, that it may be consumed. This end will be sooner obtained, and the lead part quicker, if, during the fusion, the wind through the blow-pipe be directed immediately, though not forcibly, upon the melted mass itself, until it begins to cool, then the fire must be directed on it again. The lead, which is already in a volatilising state, will by this artifice be driven out in form of a subtile smoke; and by thus continuing by turns to melt the mass, and then to blow off the lead, as has been said, until no smoke is any longer perceived, the silver will at last be obtained pure. The same observation holds good here also which was made about the gold, that, as none but very little bits of the ores can be employed in these experiments, it will be difficult to extract the silver out of a pure ore; for some part of it will fly off with the lead, and what might be left is too little to be discerned by the eye. The silver which by this means is obtained is easily distinguished from lead by the following external marks, viz. that it must be red-hot before it can be melted: it cools sooner than lead: it has a silver colour; that is to say, brighter and whiter than lead: and is harder to beat with the hammer.

46 The *mineræ cupri calciformes*, (at least some of them) when mixed with too much stone or earth, are easily reduced to copper with any flux: if the copper is found not to have its natural bright colour, it must be melted with a little borax, which purifies it. Some of these ores do not at all discover their metal, if not immediately melted with borax; the heterogenea contained in them hindering the fusion, before these are scorified by the flux.

47 The grey copper ores, which only consist of copper and sulphur, are tried almost in the same manner as the preceding. Being exposed to the flame by themselves, they will be found instantly to melt, and part of their sulphur to go off. The copper may afterwards be obtained in two ways: the one, by keeping the proof in fusion for about a minute, and then suffering it to cool; when it will be found to have a dark and uneven appearance externally, but which, after being broke, discovers the metallic copper of a globular form in its centre, surrrounded with a regule, which still contains some sulphur and a portion of the metal: the other, by being melted with borax, which last way sometimes makes the metal appear sooner.

The *mineræ cupri pyritaceæ*, containing copper, sulphur, and iron, may be tried with the blow-pipe, if they are not too poor: in these experiments the ore ought to be calcined, and after that the iron scorified. For this purpose a bit of the ore must be exposed to a slow flame, that as much of the sulphur as possible may part from it before it is melted; because the ore commonly melts very soon, and then the sulphur is more difficult to drive off. After being melted, it must be kept in fusion with a strong fire, for about a minute, that a great part of the iron may be calcined: and, after that, some borax must be added, which scorifies the iron, and turns with it to a black slag. If the ore is very rich, a metallic copper will be had in the slag, after the scorification: if the ore is of a moderate richness, the copper will still retain a little sulphur, and sometimes iron: the product will therefore be brittle, and must with great caution be separated from the slag, that it may not break into pieces; and if this product is afterwards treated in the same manner as before said, in speaking of the grey copper ores, the metal will soon be produced. But, if the ore is poor, the product after the first scorification must be brought into fusion, and afterwards melted with some fresh borax, in order to calcine and scorify the remaining portion of iron; after which it may be treated as mentioned n° 47. The copper will, in this last case, be found in a very small globule. 48

The copper is not very easily scorified with this apparatus, when it is melted together with borax; unless it has first been exposed to the fire by itself for a while, in order to be calcined. When only a little of this metal is dissolved, it instantly tinges the slag of a reddish-brown colour, and mostly opaque; but as soon as this slag is kept in fusion for a little while, it becomes quite green and transparent: and thus the presence of the copper may be discovered by the colour, when it is concealed in heterogeneous bodies, so as not to be discovered by any other experiment. 49

If metallic copper is melted with borax by a slow fire, and only for a very little time, the glass, or slag, becomes of a fine transparent blue or violet colour, inclining more or less to the green: but this colour is not properly owing to the copper, but it may rather be to its phlogiston; because the same colour is to be had in the same manner from iron: and these glasses which are coloured with either of these two metals, soon lose their colour if exposed to a strong fire, in which they are made quite clear and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire. 50

The iron ores, when pure, can never be melted by themselves, through the means of the blow-pipe alone; 51
nor

nor do they yield their metal, when melted with fluxes, because they require too strong a heat to be brought into fusion; and, as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, it is therefore easier scorified; and this is the principle on which the experiment mentioned n° 48. is founded.

52 The iron is, however, discovered without much difficulty, although it be mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the loadstone, some without any previous calcination, and others not till after having being roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but, if this metal is contained in a limestone, it does not promote the fusion, but gives the stone a dark, and sometimes a deep black colour, which always is the character of iron. A *minera ferri calciformis pura crystallisata*, is commonly of a red colour: this being exposed to the flame, becomes quite black; and is then readily attracted by the loadstone, which it was not before. Besides these signs, the iron discovers itself, by tinging the slag of a green transparent colour, inclining to brown, when only a little of the metal is scorified; but as soon as any large quantity thereof is dissolved in the slag, this becomes first a blackish brown, and afterwards quite black and opaque.

Bismuth is known by its communicating a yellowish-
53 brown colour to borax; and arsenic by its volatility, and garlick smell. Antimony, both in form of regulus and ore, is wholly volatile in the fire, when it is not mixed with any other metal (except arsenic), and is known by its particular smell; easier to be distinguished, when once known, than described. When the ore of antimony is melted upon the charcoal, it bubbles constantly during its volatilising.

54 Zinc ores are not easily tried upon the coal (n° 39.) But the regulus of zinc, exposed to the fire upon the charcoal, burns with a beautiful blue flame, and forms itself almost instantly into white flowers, which are the common flowers of zinc.

55 Cobalt is particularly remarkable for giving to the glass a blue colour, which is the zaffre or smalt. To produce this, a piece of cobalt ore must be calcined in the fire (36, 37.) and afterwards melted with borax. As soon as the glass, during the fusion, from being clear, seems to grow opaque it is a sign that it is already tinged a little; the fire is then to be discontinued, and the operator must take hold, with the nippers, of a little of the glass whilst yet hot, and draw it out slowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glass is procured, more or less thick, on which the colour may easier be seen against the day or candle light than if it were left in a globular form. The thread melts easily if only put in the flame of the candle, without the help of the blow-pipe.

If this glass is melted again with more of the cobalt, and kept in fusion for a while, the colour becomes very deep; and thus the colour may be altered, according to pleasure.

When the cobalt ore is pure, or at least contains
but little iron, a cobalt regulus is almost instantly 56
produced in the borax, during the fusion: but when it is mixed with a quantity of iron, this last metal ought first to be separated, which is easily performed, since it scorifies sooner than the cobalt; therefore, as long as the slag retains any brown or black colour (55.) it must be separated, and melted again with fresh borax, until it shew the colour.

Nickel is very seldom to be had, as its ores are 57
seldom free from mixtures of other metals. It is very difficultly tried with the blow-pipe. However, when this semi-metal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus, by means of scorification with borax, in the same manner as is mentioned (46.), because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour, when calcined: it requires a pretty strong fire before its melts, and tinges the borax with a jacinth colour. Manganese gives the same colour to borax; but its other qualities are quite different, so as not to be confounded with the nickel.

Thus we have briefly described the use of the blow- 58
pipe, and the method of employing it in the study of mineralogy. Any gentleman who is a lover of this science, will, by attending to the rules here laid down, be able in an easy manner to amuse himself in discovering the properties of those works of nature which the mineral kingdom furnishes us with. The husbandman may by its help find out what sorts of stones earths, ores, &c. there are on his estate, and to what œconomical uses they may be employed. The scientific mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a mineral system, founded on such principles as nature herself has laid down in them; and this in his own study, without being forced to have recourse to large laboratories, crucibles, furnaces, &c. which is attended with a great deal of trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this part of natural history. It is to be hoped, that the more general its use becomes, the more and sooner will its imperfections be removed, and such additions made as may be found necessary and convenient. We shall now add some hints towards these improvements, leaving to the judicious practitioner the manner of completing them.

A greater number of fluxes might perhaps be found
out, whose effects on mineral bodies might be different 59
from these already in use, whereby more distinct characters of those mineral bodies might be discovered, which now either shew ambiguous ones, or which are almost impossible to be exactly tried by the blow-pipe. Instead of the sal sodæ, some other salts might be found out, more fit for these experiments. But it is very necessary not to make use of any other fluxes than such as have no attraction to the charcoal: if they at the same time are clear and transparent when melted, as the borax and *sal fusibile microcosmicum*, it is still bet-

Of Experiments.

ter: however, the tranfparency or opacity are of no great confequence, if a fubftance is effayed only in order to difcover its fufibility, without any attention to its colour: in which cafe, fome metallic flag perhaps might be ufeful.

60 When fuch ores are to be reduced whofe metals are very apt to calcine, fuch as tin, zinc, &c. it might perhaps be of fervice to add fome phlogifton, fince the charcoal cannot afford enough of it in the open fire of thefe effays: fuch a phlogifton might be the hard refin, or fome fuch body. The manner of melting the volatile metals out of their ores *per defcenfum* might alfo perhaps be imitated: for inftance, a hole might be made in the charcoal, wide above, and very narrow at the bottom; a little piece of ore being then laid at the upper end of the hole, and covered with fome very fmall pieces of the charcoal, the flame muft be directed on the top: the metal might, perhaps, by this method gather in the hole below, removed from the violence of the fire, particularly if the ore is very fufible, &c.

61 The ufe of the pocket laboratory, as here defcribed, is chiefly calculated for a travelling mineralift. But a perfon who is always refiding at one and the fame place, may by fome fmall alteration make it more commodious to himfelf, and avoid the trouble of blowing with the mouth. For this purpofe he may have the blow-pipe go through a hole in a table, and fixed underneath to a fmall pair of bellows with double bottoms, fuch as fome of the glafs-blowers ufe, and then nothing more is required than to move the bellows with the feet during the experiment; but in this cafe a lamp may be ufed inftead of a candle. This method would be attended with a ftill greater advantage, if there were many fuch parts as fig. 2. n° 2. (Plate LV. Vol. II.) the openings of which were of different dimenfions: thefe parts might by means of a fcrew be faftened to the main body of the blow-pipe, and taken away at pleafure. The benefit of having thefe nozzles of different capacities at their ends, would be that of exciting a ftronger or weaker heat as occafion might reqnire. It would only be neceffary to obferve, that in proportion as the opening of the pipe (nozzle) is enlarged, the quantity of the flame muft be augmented by a thicker wick in the lamp, and the force of blowing increafed by means of weights laid on the bellows. A much more intenfe heat would thus be procured by a pipe of a confiderable opening at the end, by which the experiments might undoubtedly be carried farther than with the common blow-pipe.

62 A traveller, who has feldom an opportunity of carrying many things along with him, may very well be contented with this pocket laboratory, and its apparatus, which is fufficient for moft part of fuch experiments as can be made on a journey. There are, however, other things very ufeful to have at hand on a journey, which ought to make a fecond part of the pocket-laboratory, if the manner of travelling does not oppofe it: this confifts of a little box including the different acids, and one or two matraffes, in order to try the mineral bodies in liquid menftrua, if required.

63 Thefe acids are, the acid of nitre, of vitriol, and of common falt. Moft of the ftones and earths are attacked, at leaft in fome degree, by the acids; but the calcareous are the eafieft of all to be diffolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is moft ufed in thefe experiments; it diffolves the limeftone, when pure, perfectly, with a violent effervefcence, and the folution becomes clear: when the limeftone enters into fome other body, it is neverthelefs difcovered by this acid, through a greater or leffer effervefcence in proportion to the quantity of the calcareous particles, unlefs thefe are fo few as to be almoft concealed from the acid by the heterogeneous ones. In this manner, a calcareous body, which fometimes nearly refembles a filiceous or argillaceous one, may be known from thefe latter, without the help of the blow-pipe, only by pouring one or two drops of this acid upon the fubject, which is very convenient when there is no opportunity nor time for ufing this inftrument.

The gypfa, which confift of lime and the vitriolic acid, are not in the leaft attacked by the acid of nitre, 64
if they contain a fufficient quantity of their own acid, becaufe the vitriolic acid has a ftronger attraction to the lime than the acid of nitre: but if the calcareous fubftance is not perfectly faturated with the acid of vitriol, then an effervefcence arifes with the acid of nitre, more or lefs in proportion to the want of the vitriolic acid. Thefe circumftances are often very effential in diftinguifhing the calcarei and gypfa from one another.

The acid of nitre is likewife neceffary in trying the 65
zeolites, of which fome fpecies have the fingular effect to diffolve with effervefcence in the abovementioned acid; and within a quarter of an hour, or even fometimes not until feveral hours after, to change the whole folution into a clear jelly, of fo firm a confiftence, that the glafs, wherein it is contained, may be reverfed, without its falling out.

If any mineral body is tried in this menftruum, and 66
only a fmall quantity is fufpected to be diffolved, tho' it was impoffible to diftinguifh it with the eye during the folution, it can eafily be difcovered by adding to it *ad faturitatem* a clear folution of an alkali, when the diffolved part will be precipitated, and fall to the bottom. For this purpofe the fal fodæ may be very ufeful.

The acid of nitre will fuffice for making experi- 67
ments upon ftones and earths; but if the experiments are to be extended to the metals, the other two acids are alfo neceffary. As the acids are very corrofive, they muft not be kept in the ordinary pocket-laboratory, already defcribed, for fear of fpoiling the other apparatus, if the ftoppers fhould happen not to fit exactly to the necks of the bottles, and fome of the acid fhould be fpilt.

For thefe acids a feparate box muft be made, which 68
is eight inches and three quarters long, four inches broad, and five inches high (A). In this box are three long and narrow bottles, containing the acids, placed upright at one end of it, two glafs matraffes laid horizontally in the upper part, and a little drawer underneath, made on purpofe to fill the empty room below the matraffes, and to give the box a regular form; and as charcoal is not every where to be met with in travelling, a piece ought always to be kept in this drawer for the ufe of the blow-pipe.

In

(A) But thefe dimenfions, originally directed, have been fince reduced, as mentioned under n° 3. par. *penult.*

69 In order to keep the acids more cloſe in the bottles, ſince the glaſs-ſtopper is not always ſufficient, there is a glaſs-cover beſides, made ſo as to ſcrew round the neck of the bottle; and if this is nicely made, nothing can come through, though the box be inclined, or even reverſed, which ſometimes may happen. The form of the glaſs matraſſes is ſeen fig. 4. They ought to be very thin at the bottom, that they may not crack by being ſuddenly put over the fire or taken off it. In theſe matraſſes ſolutions may very eaſily be made over the flame of a candle: every mine- ral body capable of being affected by the acids in this degree of heat, may here be diſſolved, and particularly the metals.

Plate CLXXXI.

70 Another inſtrument is likewiſe neceſſary to a complete pocket-laboratory, *viz.* a waſhing-trough; in which the mineral bodies, and particularly the ores, may be ſeparated from each other, and from the adherent rock, by means of water.

This trough is very common in the laboratories, and is uſed of different ſizes; but here only one is required of a moderate ſize, ſuch as twelve inches and a half long, three inches broad at the one end, and one inch and a half at the other end (B), ſloping down from the ſides and the broad end to the bottom, where it is three quarters of an inch deep: we have given a figure of it in fig. 5. It is commonly made of wood, which ought to be choſen ſmooth, hard, and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themſelves.

It is to be obſerved, that if any matter is to be waſhed which is ſuſpected to contain ſome native metal, as ſilver or gold; a trough ſhould be procured for this purpoſe, of a very ſhallow ſlope, becauſe the minute particles of the native metal have then more power to aſſemble together at the broad end, ſeparate from the other matter.

The magnagement of this trough, or the manner of waſhing, conſiſts chiefly in this: that when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very looſe between two fingers of the left hand, and ſome light ſtrokes given on its broad end with the right, that it may move backwards and forwards, by which means the heavieſt particles aſſemble at the broad and upper end, from which the lighter ones are to be ſeparated by inclining the trough and pouring a little water on them. By repeating this proceſs, all ſuch particles as are of the ſame gravity may be collected together, ſeparate from thoſe of a different gravity, provided they all were before equally pounded; though ſuch as are of a clayiſh nature, are often very difficult to ſeparate from the reſt, which, however, is of no great conſequence to a ſkilful and experienced waſher. The waſhing proceſs is very neceſſary, as there are often rich ores, and even native metals, found concealed in earths and ſand in ſo minute particles, as not to be diſcovered by any other means.

ARRANGEMENT *of Mineral Bodies.*

71 THE bodies belonging to the mineral kingdom are divided into four different claſſes, viz.

1. *Earths*, or thoſe ſubſtances which are not ductile, are moſtly indiſſoluble in water or oil, and preſerve their conſtitution in a ſtrong heat (C).
2. *Salts:* theſe diſſolve in water, and give it a taſte; and when the quantity of water required to keep them in diſſolution is evaporated, they concrete again into ſolid and angular bodies.
3. *Inflammables*, which can be diſſolved in oils, but not in water, and are inflammable.
4. *Metals*, the heavieſt of all bodies; ſome of which are malleable, and ſome can be decompounded.

Here, however, it muſt be obſerved, that theſe claſſes are blended one with another; and therefore ſome exceptions muſt be allowed in every one of them: for inſtance, in the firſt claſs, the calcareous earth is in ſome meaſure diſſoluble in water, and pipe-clay with ſome others diminiſh ſomewhat in their bulk when kept for a long time in a calcining heat. In the third claſs, the calx of arſenic has nearly the ſame properties as ſalts; and there is no poſſible definition of ſalt, that can exclude the arſenic, though at the ſame time it is impoſſible to arrange it elſewhere than among the ſemi-metals. In the fourth claſs it is to be obſerved, that the metals and ſemi-metals, perfect or imperfect, have not the ſame qualities common to them all; becauſe ſome of them may be calcined, or deprived of their phlogiſton, in the ſame degree of fire in which others are not in the leaſt changed, unleſs particular artifices or proceſſes are made uſe of: ſome of them alſo may be made malleable, while others are by no means to be rendered ſo. That the convex ſurface metals take after being melted, is a quality not particularly belonging to them, becauſe every thing that is perfectly fluid in the fire, and has no attraction to the veſſel in which it is kept, or to any added matter, takes the ſame figure; as we find borax, *ſal fuſibile microcoſmicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has been ſaid, it is hardly worth while to invent ſuch definitions as ſhall include ſeveral ſpecies at once; we ought rather to be content with perfectly knowing them ſeparately.

The FIRST CLASS.

EARTHS, are thoſe mineral bodies, not ductile, for the moſt part not diſſoluble in water or oils, and that preſerve their conſtitution in a ſtrong heat. 72

Theſe earths are here arranged according to their conſtituent parts, ſo far as hitherto diſcovered, and are divided into nine orders.

The FIRST ORDER.

The *Calcareous* kinds. Theſe, when pure, and free from heterogeneous matters, have the following qualities common to them all: 73

1. That they become friable when burnt in the fire, and afterwards fall into a white powder.
2. That their falling into powder is promoted, if, after being burnt, they are thrown into water, whereby a ſtrong heat ariſes, and a partial ſolution.
3. They cannot be melted by themſelves into glaſs in the ſtrongeſt fire.
4. When burnt, they augment the cauſticity of the lixivium of potaſhes.

5. They

(B) Reduced dimenſions are mentioned under n° 3. par *ult*.

(C) By *earths*, the author (Mr Cronſtedt) does not mean (ſtrictly ſpeaking) only earths, but includes all the kinds of ſtones or foſſils not inflammable, ſaline, or metallic.

5. They are diffolved in acids with effervefcence, in the following manner:

a. The acid of vitriol partly unites with them, and forms a precipitate, which is a gypfeous earth; and partly fhoots into felenitical cryftals with that which is kept diffolved, after a due evaporation.

b. With the acid of common falt they make a fal ammoniacum fixum, which alfo partly precipitates itfelf.

c. The acid of nitre diffolves them perfectly, and does not part with them again, unlefs fome alkaline falt is added.

6. They melt eafily with borax into a glafs, which fuffers impreffions in a degree of heat below ignition.

7. They likewife fufe into a glafs with *fal fufibile microcofmicum* with an effervefcence (D)

8. They melt the readieft of all kinds of ftones, with the calces, into a corrofive glafs or flag.

9. They have alfo fome power of reducing certain metallic earths or calces; for inftance, thofe of lead and of bifmuth, and likewife, tho' in a lefs degree, thofe of copper and of iron: thus,

10. Do they, in this laft-mentioned article (9.), as well as in other circumftances, refemble a fixed alkaline falt; from whence alfo this whole kind is very often, and properly, called *alkaline earths*.

The calcareous earth is found,

74 I. Pure,

1. In form of powder. *Agaricus mineralis*, or *lac lunæ*.

a. White, is found in moors, and at the bottom of lakes.

b. Red.

c. Yellow.—This kind of earth feems to be an impalpable powder of mouldered limeftones abraded and collected by the waters, and is therefore common in the neighbourhoods where limeftones are found: and tho' the ftone be at fome diftance, which is fometimes the cafe, ftill nothing contradictory appears in this opinion of the origin of this fpecies; fince in that cafe it has only been carried farther by the greater rapidity of a ftronger current of water. When this earth is found in the clefts of rocks, it receives more pompous names; fuch as *gur*, *lac lunæ*, &c. It burns readily into lime, if it is previoufly ftamped, that it may better cohere: it is then, or in its native ftate, ufed for white-wafhing, but eafily rubs off by the leaft touch. At certain places in the province of Smoland in Sweden, there is found in the moors a white earth, which, by its external appearance, refembles the fpecies here defcribed; but it does not fhow any marks of effervefcence with acids, nor does it burn into lime. It were to be wifhed, that thofe who have an opportunity of getting any quantity of this latter earth, would undertake to examine it better.

75 2. Friable and compact. Chalk, *creta*.

a. White, *creta alba*, is found in England, France, and in the province of Skone in Sweden, in which laft place it is only found adherent to flint. In the two firft kingdoms there are large ftrata of this fubftance, in which flint is imbedded. This feems to indicate, that the loofe flints, or thofe difperfed on the furface of the earth, have been by fome caufes carried from their native beds; but, as yet, no one can prove, that chalk and flint are of the fame conftituent parts.—Chalk is, however a vague name, alfo applied to other earths; whence we hear of chalks of various colours; but there are none which are known to be of a calcareous nature, except this kind here defcribed, and of which there are no other varieties, otherwife than in regard to the loofenefs of the texture, or the finenefs of the particles.

3. Indurated, or hard; *Terra calcarea indurata*. Limeftone; *Lapis calcareus*. 76

A. Solid, of no vifible particles, or not granulated.

This kind varies in regard to hardnefs and colour; for inftance,

a. White.

b. Whitifh yellow.

c. Flefh-coloured, found in loofe maffes.

d. Reddifh brown.

e. Grey.

f. Variegated with many colours, and particularly called *marble*.

g. Black.

B. Grained or granulated limeftone; *Lapis calcareus particulis granulatis*. 77

1. Coarfe-grained and of a loofe texture, called *falt-flag* in Swedifh, from its refemblance to lumps of falt.

a. Reddifh yellow. *b.* White.

The grained flux fpar is alfo fometimes called *falt-flag*.

2. Fine-grained.

a. White. *b.* Semi-tranfparent, from Solfatara in Italy, in which native brimftone is found.

3. Very fine grained.

a. White and green.

b. White and black.—This fpecies has often as beautiful colours as thofe commonly called *marbles*; but the texture and coherency of its particles will not admit of a good polifh.

C. Scaly limeftone; *Lapis calcareus particulis fquamofis five fpatofis*. 78

1. With coarfe or large fcales.

a. White.

Some kinds of this lofe in a calcining heat 40 *per cent.* of their weight; and, expofed to the air, get a brownifh efflorefcence, a fign that they contain fome iron, and are a medium between a limeftone and the white iron ore called *ftahlfteine*; nor do they excite any effervefcence with acids in their crude ftate.

b. Reddifh yellow.

2. With fmall fcales.

a. White.

3. Fine glittering or fparkling.

a. White.

(D) This effervefcence is alfo made with the borax, as well as with this *fal fufibile microcofmicum*; and it is alfo to be obferved, that the glaffes made with thefe falts are quite colourlefs and tranfparent.

Calcareous Earths.

a. White.

b. Of many colours. This variety conſtitutes a great number of the foreign marbles.

This ſpecies of limeſtone takes a good poliſh, and is therefore uſed as marble whenever it is found of a fine colour. It is beſides to be remarked, that the grained and ſcaly limeſtones are found either in veins, or form whole mountains, that ſhew no ſtrata, nor ſigns of petrifactions.

79 *D.* Lime or calcareous ſpars.

(1.) Of a rhomboidal figure.

a. Tranſparent or diaphanous.

1. Refracting ſpar; *Spatum iſlandicum.*

This repreſents the objects ſeen through it double.

2. Common ſpar, which ſhews the object ſingle.

1. White, or colourleſs.

2. Yellowiſh and phoſphoreſcent.

b. Opaque; *Spatum rhomboidale opacum.*

1. White, is found in many places, moſtly in clefts, and among cryſtalliſations.

2. Black.

3. Browniſh yellow.

(2.) Foliated or plated ſpar.

This has no rhomboidal figure, but breaks into thin plates, ſo placed as to be not unlike ſheets of thin paper, laid over each other.

a. Opaque white.

80 *E.* Cryſtalliſed calcareous ſpars. *Spar Druſen* (E).

It is compoſed of the laſt-mentioned ſpar that has formed itſelf exteriorly into ſeveral planes or ſides, wherefrom many different figures ariſe, the varieties of which have not yet been fully obſerved, nor can they be exactly deſcribed. The following are therefore mentioned, only as inſtances of the moſt regular and common kinds, viz.

(1.) Tranſparent; *Spatum druſicum diaphanum.*

a. Hexagonal truncated, *Cryſtalli ſpatoſi hexagonii truncati.*

b. Pyramidal.

1. Dog's teeth; *Pyramidales diſtincti.* Found at Salberg, and in the iron mines at Dannemera in the province of Upland.

2. Balls of cryſtalliſed ſpar, *Pyramidales concreti.*

Theſe are balls which have druſen, pyramidal, octaedral, ſpars accreted in their hollows or centres: they are found at Rettwin in the province of Dalarne, and other places (F).

F. Stalactitical ſpar; *Stalactites calcareus.* Stalactites, Stone-icicle, or Drop-ſtone. 81

This is formed from water ſaturated with lime, which, while running or dropping, depoſits by degrees the calcareous earth which it has carried along with it from clefts of rocks, or from out of the earth. It is therefore commonly of a ſcaly, though ſometimes of a ſolid and ſparry texture. Its external figure depends on the place where it is formed, or the quantity of the matter contained in the water, and other like circumſtances.

(1.) Scaled ſtalactites of very fine particles.

a. Of a globular form.

1. White, the pea-ſtone.

2. Grey, *piſolithus, oolithus.* Alſo the hammites, from its reſemblance to the roes or ſpawn of fiſh. It has been exhibited by authors as petrified roes. The Ketton free-ſtone, of Rutlandſhire, is a remarkable ſtone of this ſort.

b. Hollow, in the form of a cone.

1. White, is found every-where in vaults made with mortar, and through which water has had an opportunity to penetrate; and alſo in grottos dug in rocks of limeſtone.

c. Of an indeterminate figure. *Sinter.*

d. Of coherent hollow cones.

Of this kind is a ſtalactitical cruſt, which has formed a ſtratum, or rather filled a fiſſure between the ſtrata of the earth, at Helſingborg in the province of Skone; it is of a very ſingular figure, reſembling conical caps of paper placed and fixed one in the other, diminiſhing by degrees both in height and the other dimenſions.

2. Solid

(E) The tranſlator of Mr Cronſtedt's treatiſe has adopted this German term *druſen* into the Engliſh language, for a cluſter of regular-figured bodies, as a groupe conveys the idea of a cluſter only, whether regular or of indeterminate figures.

(F) The name *ſpar* is very well known, and only uſed to determine a certain figure, viz. when a ſtone breaks into a rhomboidal, cubical, or a plated form, with ſmooth and poliſhed ſurfaces, it is called *ſpar:* and as it is thus applied to ſtones of different kinds, without any regard to their principles, one ought neceſſarily to add ſome term to expreſs the conſtituent parts at the ſame time that the figure is mentioned; for inſtance, calcareous ſpar, gypſeous ſpar, flux ſpar, ſhorl or cockle ſpar, &c. This term, however, is applied only to earths, and ſuch ores as are of the ſame figure as the lead ſpar, &c.

All cryſtalliſed ſpars, when broken, ſhow the ſparry figure in their particles, and the cryſtalliſation is to be aſcribed to the empty ſpace left by the contraction of the ſparry principle: ſuch holes filled with druſen of ſpars, are in Swediſh called *drake*, or *druſe-hol.*

The figure of the cryſtals varies more in this genus than in any other, for which no reaſon can be aſſigned; it ought not to be aſcribed to ſalts, as long as the preſence of any ſuch cannot be proved: but there are ſtrong indications to ſuſpect, that other ſubſtances may likewiſe have received the ſame property to aſſume an angular ſurface on certain occaſions. See Mr Cronſtedt's Introductory Speech at the Royal Academy of Sciences at Stockholm.

Beſides, the conſideration of thoſe figures is a thing of more curioſity than of real uſe, becauſe no miner has yet been able to make any concluſion relative to the quantity or quality of the ores, from the difference of the figures of ſpars found along with them; and the grotto-makers never take any notice of the angles or ſides, but think it ſufficient for their purpoſe if they make a fine or glittering appearance at a diſtance.

It would, nevertheleſs, be well if any one would take upon himſelf the trouble to obſerve whether each ſpecies of ſpar has not a certain determinate number of figures or ſides, within which it is confined, in its accretions. This it has hitherto been impoſſible to do, becauſe all ſpecies of ſpars have been confounded together, without regard to their different principles.

Calcareous Earths.

(2.) Solid ftalactites of a fparry texture.

a. Hollow, and in form of a cone.

1. White, and femitranfparent.

In making lime-water, one may obferve how the lime gathers firft like a pellicle on the furface of the water, and afterwards, when this breaks, falls down to the bottom in form of a fcaly fediment, which is called *cremor calcis:* after that a new pellicle is formed, which likewife falls down; and in this manner it continues for a long while, although the lime-water had before been paffed through a filtre. This we may alfo imagine to be the way in which the works of nature are performed: whence the ftalactites commonly is of a fcaly texture, or at leaft difcovers fome tendency towards it. But a ftalactites of a fparry texture, fuch as above-mentioned from Rouen, may be fuppofed to be owing to a more copious principle concurring at once: and in the fame manner the fparry limeftone and its cryftallifations feem likewife to have been produced; fince they, as far as we know, are only found in clefts, which, when they have been filled up with a ftony matter, the Swedifh miners call *klyfter*, and *gangar*, or *veins*. In regard to this, the ftalactites, the fparry limeftone, and alfo its cryftallifations, might all be ranked under the fame title in a fyftematical defcription, as very little different from one another, if it were not neceffary, in defcribing mines and other works, to give them their feparate names; becaufe it is certain, that a piece which is broken from large fpar-cryftals, or from fparry ftalactites, may in a cabinet pafs extremely well for a common fparry limeftone, without leaving any fufpicion of its former figure before it was broke.

82 II. Satiated or united with the acid of vitriol. Gypfum, Plafter-ftone, or Parget.

This is,

1. Loofer and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervefcence with acids; or, at moft, it effervefces but in a very flight degree, and then only in proportion as it wants fome of the vitriolic acid to complete the faturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a mafs, which foon hardens; and then,
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itfelf as the limeftone, and fhews moftly the fame effects with other bodies as the lime-ftone: the acid of vitriol feems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fufion, owing to the nature of both the falts.
8. When a fmall quantity of any gypfum is melted together with borax, the glafs becomes colourlefs and tranfparent; but fome forts of alabafter and fparry gypfa, when melted in fome quantity with borax, yield a fine yellow tranfparent colour, refembling that of the beft topazes. This phænomenon might probably happen with every one of the gypfeous kind. But it is to be obferved, that if too much of fuch gypfum is ufed in proportion to the borax, the glafs becomes opaque, juft as it happens with the pure limeftone.
9. Burnt with a phlogifton, it fmells of fulphur, and may as well by that means, as by both the alkaline falts, be decompounded; but for this purpofe there ought to be five or fix times as much weight of falt as of gypfum.
10. Being thus decompounded, the calx or earth which is left fhows commonly fome marks of iron.

The gypfeous earth is found, 83

(1.) Loofe and friable; *Terra gypfea pulverulenta.* Gypfeous earth, properly fo called; *Guhr.*

a. White.

(2.) Indurated,

A. Solid, or of no vifible particles, Alabafter. 84

This ftone is very eafy to faw and cut, and takes a dull polifh. It is not always found fatiated with the acid of vitriol.

a, White, alabafter.

1. Clear and tranfparent.
2. Opaque.

b. Yellow.

1. Tranfparent, from the Eaftern countries.
2. Opaque.

B. Gypfum of a fcaled or granulated ftructure. 85
This is the common plafter-ftone.

1. With coarfe fcales.
   a. White.
2. With fmall fcales. *a.* Yellowifh. *b.* Greyifh.

C. Fibrous gypfum, or plafter-ftone, improperly 86
(though commonly) called *Englifh talc* by our druggifts.

1. With the fibres coarfe.
   a. White, from Livonia.
2. With fine fibres.
   a. White.

D. Spar-like gypfum. Selenites. This by fome is 87
alfo called *glacies mariæ;* and is confounded with the clear and tranfparent mica.

1. Pure felenites.
   A. Tranfparent.
   a. Colourlefs.
   b. Yellowifh.
2. Spar-like gypfum; *Marmor metallicum.*

This ftone, on account of its heavinefs, which comes near to that of tin or iron, is fufpected to contain fomething metallic; but, as far as is hitherto known, no one has yet been able to extract any metal from it, except fome traces of iron, which is no more than what all other gypfa contain.

A. Semitranfparent; *fpatum Bononienfe*, the Bononian ftone, or phofphorus. Its fpecific gravity is 4,5000 : 1000.

B. Opaque.
a. White.

3. Liverftone, fo called by the Swedes and Germans.

E. Chry-

88 *E.* Cryftallifed gypfum. Gypfeous drufen; *drufeæ gypfeæ*.

(1.) Drufen of cryftals of pure fparry gypfum.

A. Wedge-formed, are compofed of a pure fpar-like gypfum.

1. Clear and colourlefs. 2. Whitifh yellow.

B. Capillary. *a.* Opaque, whitifh yellow.

C. Of ponderous fpar-like gypfum; *Marmor metallicum drufìcum.*

1. Jagged or like cocks combs, *criftati.* Thefe refemble cocks combs, and are found in clefts or fiffures accreted on the furfaces of balls of the fame fubftance. 2. White. 3. Reddifh.

89 *F.* Stalactitical gypfum. *Gips finter.*

This perhaps may be found of as many different figures as the calcareous ftalactites, or finters.

Mr Cronftedt has only feen the following, *viz.*

1. Of no vifible particles; in French, *grignard.*

A. Of an irregular figure.

a. Yellow.

b. White.

This is ufed in feveral works as alabafter, efpecially when it is found in large pieces; and then it commonly varies in colour between white and yellow, as alfo in tranfparency and opacity.

2. Of a fpar-like texture.

A. In form of a cone.

a. White and yellow.

B. Of an irregular figure.

a. White.

Gypfeous foffils abound in England. Plafter-ftone, granulated and folid, fome fo very fine as to be alabafter, that is, take a furface and politure, are plenty in Derbyfhire and Nottinghamfhire, where are large pits of it, and alfo in moft of the cliffs of the Severn, efpecially at the Old Paffage in Somerfetfhire. A very fine femipellucid folid alabafter is found in Derbyfhire. Fibrous talcs, very fine, are found in the fame pits of plafter-ftone above-mentioned, and many other places. Selenites of many kinds abound in England in clays, infomuch that it is needlefs to enumerate the places. Very fine gypfeous drufen are found in Sheppy-ifle; and fome, perfectly pellucid as cryftal, and large, have been dug from the falt-rocks at Nantwich in Chefhire. The *felenites rhomboidalis*, a rare foffil in other countries, is frequently found in England; but Shotover-hill, in Oxfordfhire, is famous for it. The ifle of Sheppy affords a kind peculiar to that fmall fpot of ground, and not found any where elfe in the world, fibrous, and always accreting in radiations like a ftar on the feptaria, thence called *ftella feptarii.*

90 III. Calcareous earth fatiated with the acid of common falt. *Sal ammoniacum fixum naturale.*

This is found,

1. In fea-water.

2. In falt-pits.

It is formed in great quantities at the bottoms of the falt-pans of the falt-works. It attracts the moifture of the air.

IV. Calcareous earth united with the inflammable fubftance.

These have a very offenfive fmell, at leaft when they are rubbed, and receive their colour from the phlogifton, being dark or black in proportion as it predominates. 91

(1.) Calcareous earth mixed with phlogifton alone; *Lapis fuillus*, fetid ftone and fpar, or fwine-ftone and fpar. Perhaps the fmell of this ftone may not be fo difagreeable to every one: it goes foon off in the fire. Its varieties, in regard to the texture, are as follow: 92

A. Solid, or of no vifible or diftinct particles.

a. Black.

B. Grained.

a. Blackifh brown.

C. Scaly, *particulis micaceis.*

1. With coarfe fcales.

a. Black.

2. With fine glittering or fparkling fcales.

a. Brown.

D. Sparry.

a. Black.

b. Light brown.

c. Whitifh yellow.

E. Cryftallifed.

1. In a globular form.

(2.) Calcareous earth united with phlogifton and the vitriolic acid. *Leberftein* of the Germans and Swedes. *Lapis hepaticus.* 93

This ftone fometimes readily, at other times only when rubbed, fmells like the *hepar fulphuris*, or gun-powder. It excites no effervefcence with acids, and is a medium between the gypfum and the fœtid ftones (93), to which it has, however, generally been referred, although no lime can be made from it; whereas they are the fitteft of all the different limeftones to be burnt into lime. It is found,

A. Scaly. 94

1. With coarfe fcales.

a. Whitifh yellow.

2. With fine glittering or fparkling fcales.

a. Black.

The method that nature takes in combining thofe matters which compofe the liver-ftone, may perhaps be the fame as when a limeftone is laid in a heap of mundic while it is roafting; becaufe there the fulphur unites itfelf with the limeftone, whereby the limeftone acquires that fmell common to liver of fulphur, inftead of which the vitriolic acid alone enters into the formation of gypfum. How the fulphur combines itfelf may likewife be obferved in the flate-balls or kernels from Andrarum alum-mines, where it fometimes combines itfelf with a martial earth, with which this flate abounds, and forms therewith pyrites within the very flate-balls. The fetid or fwine ftones, and the liver-ftone, are, in regard to the ftructure of their parts, fubject to the fame varieties as the other fpecies of limeftone: and it is to be obferved, that a volatile alkali is commonly fuppofed to have entered into the compofition of the fetid ftones, though it has never yet been difcovered by any experiment.

95 V. Calcareous earths blended with an argillaceous earth. Marle, *Marga*.

1. When crude, it makes an effervescence with acids; but,
2. Not after having been burnt; by which operation it is observed to harden, in proportion as the clay exceeds the calcareous substance.
3. It easily melts by itself into a glass, and even when it is mixed with the most refractory clay.
4. It is of great use in promoting the growth of vegetables, since the clay tempers the drying quality of the calcareous earth.
5. When burnt in a calcining heat, it readily attracts water: and, exposed to the air, in time it falls into a powder.

The varieties of this kind worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. We shall specify the following examples.

96 *A*. Loose and compact, *Marga friabilis*. This dissolves in water like common clay.

a. Rdedish brown.

b. Pale red. This, when burnt, is of a yellowish colour, and used for making earthen-ware in some places.

97 *B*. Semi-indurated, *Marga indurata aëre fatescens*.

It is nearly as hard as stone when first dug up, but moulders in the open air. It is mostly slatty, and is not uncommon in the slate-rocks of Sweden, where it lies between the thick beds of slatty limestone, and is also found by itself forming very thick strata. It does not dissolve in water, till by a considerable length of time it has mouldered to a powder.

a. Grey.

b. Red.

98 *C*. Indurated or stone marle.

A. In loose pieces, *Marga indurata amorpha*; by the Germans called *duckstein*, or *tophstein*.

a. White.

b. Grey.

It is formed from a sediment which the water carries along with it.

B. In continued strata. Hard slatty marle.

99 VI. Calcareous earth united with a metallic calx.

Here, as well as in the others, such a mixture or combination is to be understood, as cannot be discovered by the eye alone, without the help of some other means.

The subjects belonging to this division lose the property of raising an effervescence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found some that contained 20 or 30 *per cent*. of metal, and yet have shewn their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, *viz*.

100 (1.) Calcareous earth united with iron. White sparlike iron ore, *Minera ferri alba*. The *stahlstein* or *weises eisenerz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.
2. It becomes black in the open air, as likewise in a calcining heat.
3. In this last circumstance it loses 30 or 40 *per cent*. of its weight, which by distillation has been found owing to the water that evaporates; and it is possible that some small quantity of vitriolic acid may, at the same time, evaporate with the water.
4. It is of all the iron ores the most easy to melt, and is very corrosive when melted.

This kind is found,

A. Loose; the mouldered part of the indurated sort.

a. Black, like soot.

b. Dark brown, somewhat resembling umbre.

B. Indurated.

1. Solid, of no distinct particles.

a. Red. Looks like red ochre, or the red hæmatites, but dissolves in the acid of nitre with a great effervescence.

2. Scaly, *particulis micaceis*.

a. White. *b*. Blackish grey.

3. Spar-like.

a. Light brown.

4. Drusen.

a. Blackish brown. *b*. White.

1. Porous. This is often called *eisenblute*, or *flos ferri*.
2. Cellular.

(2.) Calcareous earth united with copper. 101

A. Loose and friable. Mountain blue. Germanicè, *Bergblau*.

This dissolves in aquafortis with effervescence.

B. Indurated.

1. Pure calcareous earth mixed with calx of copper. Armenian stone, *lapis Armenus*. Such, according to the description of authors, ought the nature of the stone called *lapis Armenus* to be, though the druggists substitute in its stead a pale blue lapis lazuli, free from marcasite. 102
2. Gypseous earth united with calx of copper. Is of a green colour; and might perhaps be called *turquoise ore*, or *malachites*; though we do not know if all sorts of turquoise ore are of this nature. 103

a. Semi-transparent, is found at Ardal in Norway. By chemistry we know, that alkaline salts produce a blue colour with copper, which is changed into green as soon as any acid is added; and from thence the reason is obvious why a green colour may be found among calcareous copper ores, *viz*. when the vitriolic acid is in the neighbourhood of it.

(3.) Calcareous earth united with the calx of lead, 104

This is a lead ochre, or a spar-like lead ore, which, in its formation, has been mixed with a calcareous earth, and for that reason effervesces with acids.

A. Loose and friable.

a. White, from Kristersberget at Nya Kopparberget in Westmanland.

B. Indurated.

1. Scaly.

Siliceous Earths.

a. Yellowish.

Both these varieties contain a considerable quantity of lead, viz. 40 *per cent.* more or less; and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore. Thus may these be distinguished from other lead-ochres and spar-like lead ores, which are much richer in lead, and never effervesce with acids. These last mentioned also seem to be produced by nature, nearly as the spar-like lead ores, and as the *flores saturni* are formed in calcining a regule of lead.

The Second Order.

105 The *Siliceous* kind.

This siliceous earth is, of all others, the most difficult to describe and to distinguish perfectly: however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated state it is hard, if not in regard to the whole, yet at least in regard to each particle of it, in a degree sufficient to strike fire with steel, and to scratch it, when rubbed against it, though the steel be ever so well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itself, neither in a reverberatory, nor in a blast furnace.
3. After being burnt, it does not fall to a powder, neither in the open air, nor in water, as the calcareous order does, but becomes only a little looser and more cracked by the fire, unless it has been very slowly and by degrees heated.
4. It excites no effervescence with acids.
5. In the fire it melts easiest of all to a glass with the fixed alkaline salt; and hence it has got the name of *vitrescent*, though this name is, properly speaking, less applicable to this order than to a great many other earths.

The mineral bodies that are comprehended in this order, are, indeed, somewhat different from one another. This difference, however, on first sight may be discerned: but, in regard to their effects in the fire, and other chemical experiments, it cannot be esteemed of any great consequence, at least while we are no farther advanced in the art of decompounding these hard bodies, and as long as no one has thought it worth the trouble and expence to use those means which are already discovered for this purpose; namely, the burning-glass or concave mirror; and to continue such experiments which Mr Pott has ingeniously begun as a basis for his *Lithogeognosia*. For want of this, there is no other way left, than to consider these bodies as simple substances, (how much soever compounded they may be), in the following manner.

106 I. Diamond. *Adamas gemma.*

Which,

1. Of all stones, is the hardest.
2. Is commonly clear, or transparent; which quality, however, may, perhaps, only belong to its crystals, but not to the rock itself from which they have their origin.
2. Its specific gravity is nearest 3,500. When brought to Europe in its rough state, it is in form either of round pebbles with shining surfaces, or of crystals of an octoëdral form.

a. Colourless, or diaphanous, or the diamond properly so called.

But it also retains this name when it is tinged somewhat red or yellow. Being rubbed, it discovers some electrical qualities, and attracts the mastic.

b. Red; Ruby. *Adamas ruber; Rubinus.*— 107
Which, by lapidaries and jewellers, is, in regard to the colour, divided into,

1. The ruby of a deep red colour inclining a little to purple.
2. Spinell, of a dark colour.
3. The balass, pale red, inclining to violet. This is supposed to be the mother of the rubies.
4. The rubicell, reddish yellow.

However, all authors do not agree in the characters of these stones.

II. Sapphire. *Sapphyrus gemma.* 108

It is transparent, of a blue colour; and is said to be in hardness next to the ruby, or diamond.

Sapphires are said to be found in Alsatia, at St Amarin: but accounts of this kind are in general not to be depended upon, as the fluors are frequently met with in collections and the druggists shops under the name of *saphires*, when they are of a deep blue colour; not to mention that the quartz is always termed a precious stone, whenever it is found clear and of a fine colour. The sapphire is said to lose its blue colour in the fire. Those which are but a little tinged are called *white sapphires*. The sapphire is seldom found of a very deep blue colour, and free from parallel flaws which run through it.

III. Topaz. *Topazius gemma.* 109

This is a precious stone which, when rough and perfect, is sold in a crystallised form. At Schneckenstein in Saxony, these crystals are found of a prismatical octoëdral form, with no points, but flat, and with some facets at the top; however, without doubt the oriental topazes have another figure.

Experiments by fire have been made on the Schneckenstein topazes by Mr Pott, as may be seen in his Lithogeognosia.

To this kind may be referred,

a. The pale yellow topaz; which is nearly uncoloured, and is found at Schneckenstein.
b. The yellow topaz, from Schneckenstein.
c. Deep yellow, or gold-coloured topaz, or oriental topaz.
d. Orange-coloured topaz.
e. The yellowish green topaz, or *chrysolite*.

It is of a grass-green colour, and may perhaps belong to some other species, which might be discovered, if it could be obtained rough, or in its matrix, and large enough or in such quantity as is necessary for experiments to be made.

f. The yellowish green and cloudy topaz, the *chrysoprase*.

This is perhaps the substance which serves as a matrix to the chrysolite: for those which have been seen of this kind are like the clear-veined, called

called in Swedifh *milk-cryftal*, and *quartz*, which is of the firft degree of cryftallifation.

g. Bluifh green topaz, or the beryl.

This varies in its colours; and is called, when,

1. Of a fea-green colour, the *aqua-marine*;
2. When more green, the *beryl*.

They are found in the ftream-works in Saxony and Bohemia, in form of pebbles, or round pieces.

110 IV. Emerald. *Smaragdus gemma.*

Its chief colour is green, and is tranfparent. It is the fofteft of precious ftones, and when heated it is phofphorefcent like the fluors. What in fome cabinets is given out for its matrix, and faid to come from Egypt, is nothing elfe than a deep green cockle-fpar; of which colour we likewife find cockle, or fhirl, in the ifland of Uto near Stockholm, and at Norbery in the province of Weftmanland in Sweden.

Mr Maillet informs us, that in former times the beft emeralds were found in Egypt.

111 To the precious ftones belong alfo the jacinths, or hyacinths; which are cryftals harder than quartz cryftals, tranfparent, of a fine reddifh-yellow colour when in their full luftre, and formed in prifms pointed at both ends: thefe points are always regular, in regard to the number of the facets, being four on each point; but the facets feldom tally: the fides alfo which form the main body, or column, are very uncertain in regard both to their number and fhape; for they are found of four, five, fix, feven, and fometimes of eight, fides: further, the column or prifm is in fome alfo fo compreffed, as almoft to refemble the face of a fpherical facetted garnet. Thefe cryftals lofe their colour, become white, and do not melt in the fire; by which qualities chiefly they may be diftinguifhed from garnets, which are likewife fometimes found of a colour not inferior to the true jacinths. The author had not, at the time when he wrote this effay, feen the true jacinths; but fays that the reddifh yellow garnets from Greenland are fold by the jewellers for jacinths; fo are likewife the Eaft Indian garnets of the fame colour; and, what is ftill more, there are fome jewellers that do not know the true diftinctions between a jacinth and a garnet at all, but buy and fell the garnets for jacinths, when they are of a fine reddifh yellow colour; this muft in particular be owing to the fcarcity of the true jacinth.

Mr Cronftedt fays he lately got fome jacinths of a quadrangular figure, which did not melt in the fire, but only became colourlefs.

112 V. Quartz. *Quartzum.*

This ftone is very common in Europe, and eafier to be known than defcribed. It is diftinguifhed from the other kinds of the filiceous order, by the following qualities.

1. That it is moft generally cracked throughout, even in the rock itfelf; whereby,
2. As well as by its nature, it breaks irregularly, and into fharp fragments.
3. That it cannot eafily be made red-hot, without cracking ftill more.
4. It never decays in the air.
5. Melted with pot-afhes, it gives a more folid and fixed glafs than any other of the filiceous order.
6. When there has been no interruption in its natural accretion, its fubftance always cryftallifes into hexagonal prifms pointed at one or both ends.
7. It occurs in clefts, fiffures, and fmall veins in rocks. It very feldom forms large veins, and ftill feldomer whole mountains, without being mixed with heterogeneous fubftances.

The quartz is found,

(1.) Pure.

A. Solid, of no vifible particles with a gloffy furface. Fat quartz.

a. Uncoloured and clear, *diaphanum*. This has no cryftallifed form, but is neverthelefs as clear as quartz cryftals of the beft water.
b. White, the common fat quartz.
c. Blue.
d. Violet.

B. Grained.

a. White.
b. Pale green.

C. Sparry quartz.

This is the fcarceft; and ought not to be confounded with the white felt-fpat, being of a fmoother appearance, and breaking into larger and more irregular planes.

a. Whitifh yellow. *b.* White.

D. Cryftallifed quartz. Rock cryftal. Quartz cryftal.

Its figure is already defcribed; and, in regard to the colours, the following varieties occur.

1. Opaque, or femi-tranfparent.
   a. White, or of a milk colour.
   b. Red, or of a carnelian colour.
   c. Black.
2. Clear.
   a. Blackifh brown, fmoky topaz, or *raunch topas* of the Germans.
   b. Yellow; found in Bohemia, and fold inftead of topazes.
   c. Violet; the amethyft.
   d. Uncoloured; rock-cryftal, properly fo called. When thefe coloured cryftals are not clear, they are called *flufs;* for inftance, *topaz-flufs*, *amethyft-flus*, &c.

(2.) Impure quartz.

A. Mixed with iron, in form of a black calx. This is of a gloffy texture, and contains a great quantity of iron.

B. Mixed with copper in form of a red calx.
a. Red.

VI. The flint. *Silex pyromachus*, *Lapis corneus*, or *hornftein* of the Germans. 113

This is equally common with the quartz, and it is full as difficult to defcribe it; efpecially as it forms a kind of intermediate fubftance between quartz and jafper, both which it fo nearly refembles, that it is not eafy to point out fuch characters as fhall readily diftinguifh it from them. The beft way, perhaps, will be to fpeak of its properties

perties comparatively; and then we may ſay, that,

1. It is more uniformly ſolid, and not ſo much cracked in the maſs as the quartz; and,
2. It is more pellucid than the jaſper.
3. It bears being expoſed to the air, without decaying, better than the jaſper, but not ſo well as the quartz.
4. It is better for making of glaſs than the jaſper, but is not quite ſo good as quartz for that purpoſe.
5. Whenever there has been an opportunity in this matter of its ſhooting into cryſtals, quartz cryſtals are always found in it; juſt as if the quartz had made one of its conſtituent parts, and had on certain circumſtances been ſqueezed out of it; this is to be ſeen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often ſhows moſt evident marks of having been originally in a ſoft and ſlimy ſtate.

The ſeveral varieties of this ſpecies have obtained diſtinct names, more with reſpect to their colours than from any real difference in their ſubſtance; but theſe are ſtill neceſſary to be retained, as the only names uſed by jewellers and others, who know how to value them accordingly.

114 (1.) The opal. *Opalus pæderota.*

It is the moſt beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and muſt therefore be deſcribed under both theſe circumſtances.

a. The opal of Nonnius, the ſangenon of the Indians.

This appears olive-coloured by reflection, and ſeems then to be opaque; but when held againſt the light, is found tranſparent, and of a fine ruby red.

That opal is ſuppoſed to have been of this kind, which Pliny mentions in his Natural Hiſtory, chap. 307. ſect. 21. and which he ſays was in the ſenator Nonius's poſſeſſion, who rather ſuffered baniſhment than part with it to Antony.

This ſtone was at that time valued in Rome at 20,000 ſeſterces. But the ſtone here particularly deſcribed, was found in the ruins of Alexandria; it is about the ſize of a hazle-nut, and was bought for a trifle of a French druggiſt, named *Roboly*, and preſented to the French general conſul Lironcourt, who afterwards offered it to ſale in ſeveral places for the ſum of 40,000 rixdollars. See Haſſelquiſt's Travel's to the Eaſt, under the article of OPAL.

This very ſtone was in the year 1763 in the poſſeſſion of his excellency the duke de Nivernois, then ambaſſador to the Britiſh court.

There is, however, another of the ſame kind in Sweden, which by reflection appears rather brown; but by refraction is red, with violet veins.

b. The white opal. Its ground is white, of a glaſs-like complexion, from whence are thrown out green, yellow, and bluiſh rays; but it is of a reddiſh or rather flame colour, when held againſt the light.

1. Of many colours. The oriental opal.
2. Of a milky colour.
3. Bluiſh, and ſemi-tranſparent. This is not ſo much valued as thoſe which are more opaque, becauſe it is eaſier to be imitated by art.

(2.) The cat's eye. *Pſeudopalus.* 115

This ſtone is opaque, and reflects green and yellowiſh rays from its ſurface, and is found in Siberia.

(3.) The onyx. *Onyx camehuja.* Memphites. 116

This ſtone is the hardeſt of the flinty tribe; and conſiſts of differently coloured veins, which run parallel to one another, ſometimes in ſtraight, ſometimes in curved lines. It is found of two ſorts.

a. Nail-coloured onyx, having pale fleſh-coloured and white lines. From the river Tomm in Siberia.

b. With black and white lines. The oriental onyx.

The old Romans were accuſtomed to cut figures in relief on the ſtraight-lined onyxes, which they called *camehuja;* theſe are ſtill counterfeited, and called *camayeu*. Thoſe which conſiſt of concentric circles were called *memphites;* and we have now of this kind cut to be ſet in rings, under the name of *occhi di gatti*, which, however, ought not to be confounded with the pſeudopal, or cat's eye.

(4.) The chalcedony, or white agate. 117

Is a flint of a white colour, like milk diluted with water, more or leſs opaque: it has veins, circles, and round ſpots. It is ſaid to be ſofter than the onyx, but much harder than thoſe agates which are ſometimes found of the ſame colour.

a. The white opaque chalcedony, or *cacholong*, from the Buckhariſh Calmucks. This was firſt made known by one Renez, a Swediſh officer, who for ſeveral years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domeſtic veſſels out of it.

b. Of white and ſemi-tranſparent ſtrata; from Ceylon.

c. Bluiſh grey; from Ceylon and Siberia.

(5.) The carnelian. *Carniolus.* 118

Is of a browniſh red colour, and often entirely brown. Its name is originally derived from its reſemblance to fleſh, or to water mixed with blood.

a. Red.

b. Yellowiſh brown, looks like yellow amber, from the river Tomm in Siberia. It is ſaid not to be ſo hard as the chalcedony.

(6.) The ſardonyx. 119

Is a mixture of the chalcedony and carnelian, ſometimes ſtratum-wiſe, and ſometimes confuſedly blended and mixed together.

a. Striped with white and red ſtrata: this ſerves as well cut in cameo as the onyx.

b. White, with red dendritical figures. This very much reſembles that agate which is called the *mocha ſtone*, but with this difference, that the figures are of a red colour in this, inſtead of black, as in that agate.

Between the onyx, carnelian, chalcedony, ſardonyx, and agate, there ſeems to be no real difference,

difference, except fome inexplicable degrees of hardnefs.

120 (7.) The agate; *Achates*.

This name is given to flints that are variegated with different colours, promifcuoufly blended together; and they are efteemed in proportion to their mixture of colours, their beauty, and elegance. Hence alfo they have obtained variety of names, moftly Greek, as if the bufinefs of the lapidary in cutting of them, and admiring their feveral beauties and figures, had been derived from that nation alone.

a. Brown opaque agate, with black veins, and dendritical figures; the Egyptian pebble.
b. Of a chalcedony colour, *achates chalcedonifans*.
c. Semi-tranfparent, with lines of a blackifh brown colour, and dendritical figures; the mocha ftone. This is much efteemed, and makes a valuable part of fome collections, where it has a place chiefly for the fake of its figures, refembling vegetables, animals, &c. which however are often improved by art.
d. Semi-tranfparent, with red dots; *Gemma divi Stephani*. When the points are very minute, fo as to give the ftone a red appearance, it is by fome called *Sardea*.
e. Semi-tranfparent, with clouds of an orange colour.
f. Deep red or violet, and femi-tranfparent.
g. Of many colours, or variegated.
h. Black.

121 VII. Jafper. *Jafpis*.

All the opaque flints are called by this name, whofe texture refembles dry clay, and which have no other known quality, whereby they may be diftinguifhed from other flints, except that they may be more eafily melted in the fire; and this quality perhaps may proceed from fome heterogeneous mixture, probably of iron.

(1.) Pure jafper; which by no means yet known can be decompounded.
a. Green with red fpecks or dots; the *heliotrope*, or blood-ftone. *b.* Green. *c.* Red. *d.* Yellow. *e.* Red with yellow fpots and veins. *f.* Black.

(2.) Jafper containing iron; *Jafpis martialis, Sinople*.
A. Coarfe-grained.
a. Red and reddifh brown; *finople*.
B. Steel-grained, or fine-grained.
a. Reddifh brown: looks like the red ochre or chalk ufed for drawing; and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.
C. Of a folid and fhining texture, like a flag.
a. Liver-coloured; and, *b.* Deep red. *c.* Yellow. This laft mentioned, when calcined, is attracted by the loadftone; and being effayed, yields 12 to 15 *per cent.* of iron.

122 VIII. Rhombic quartz; *Spatum fcintillans*, *Feltfpatum*.

This has its name from its figure, but feems to be of the fame fubftance as the jafper. We have not, however, ranked them together, for want of true marks to diftinguifh the different forts of the flinty tribe from one another.

This kind is found,

1. Sparry.
a. White.
b. Reddifh brown.
c. Pale yellow.
d. Greenifh.
This laft mentioned refembles very much the fchorl or cockle-fpar; but is neither fo eafy to melt in the fire, nor of fo exact a figure.
2. Chryftallifed.
a. In feparate or diftinct rhomboidal cryftals.

The THIRD ORDER.

THE *Garnet* kind. *Terræ granateæ*. 123

The matter compofing the fubftance of garnet, and fchorl or cockle, except that fmall portion which is metallic, does in its indurated ftate refemble the filiceous tribe, fo far as relates to external appearance and hardnefs; and therefore we would willingly have followed the opinion commonly received, of confidering thefe two fubftances as arifing from one another, if we had not been perfuaded to the contrary by the following qualities of the garnet.

1. It is more fufible, in proportion as it contains lefs metallic matter, and is more tranfparent or glaffy in its texture; which is quite contrary to the filiceous kind.
2. This is the reafon, perhaps, why the garnet, mixed with the falt of kelp, may on a piece of charcoal be converted to a glafs by the blowpipe, which cannot be done with the flints: and,
3. Why the moft tranfparent garnet may, without any addition, be brought to a black opaque flag by the fame means.
4. It is never, fo far as is hitherto known, found pure, or without fome mixture of metal; and efpecially iron, which may be extracted by the common methods.
5. The garnet matter, during the cryftallifation, has either been formed in fmall detached quantities, or elfe has had the power of fhooting into cryftals, though clofely confined in different fubftances: fince garnets are generally found difperfed in other folid ftones, and oftentimes in the harder ones, fuch as quartz and chert.

I. Garnet; *Granatus*. Which is a heavy and hard kind of ftone, cryftallifing in form of polygonal balls, and is moftly of a red, or reddifh brown colour. 124

A. garnet mixed with iron; *Granatus martialis*.
1. Coarfe-grained garnet-ftones, without any particular figure; in Swedifh called *Granatberg*; in German, *Granatftein*. *a.* Reddifh-brown garnet. *b.* Whitifh-yellow. *c.* Pale yellow.
2. Cryftallifed garnet.
a. Black. *b.* Red: femi-tranfparent, and cracked; tranfparent. *c.* Reddifh yellow tranfparent; the jacinth, or hyacinth. *d.* Reddifh brown. *e.* Green. *f.* Yellowifh green.

B. Garnet mixed with iron and tin.
1. Coarfe grained, without any particular figure.
a. Blackifh-brown.

2. Chryftal-

2. Cryftallifed.

a. Blackifh-brown.

b. Light-green or white.

The *bergs-radets*, or mine-mafters, Mr Brandt and Mr Rinman, have publifhed fome experiments on this kind of garnet, in the Memoirs of the Royal Academy of Sciences at Stockholm.

C. Garnet mixed with iron and lead.

1. Cryftallifed.

a. A reddifh-brown, difcovered and accurately examined by the bergs-radet Mr Von Swab (G).

125 II. Cockle, or fhirl. *Bafaltes; Corneus cryftallifatus Wallerii; Stannum cryftallis columnaribus nigris Linnæi.*—Is a heavy and hard kind of ftone, which fhoots into cryftals of a prifmatical figure, and whofe chief colours are black or green. Its fpecific gravity is the fame as the garnets, viz. between 3000 and 3400, though always proportionable to their different folidity.

126 *A.* Cockle, or fhirl, mixed with iron.

1. Coarfe, without any determined figure.

a. Green, found in moft of the Swedifh iron mines.

127 2. Sparry.

a. Deep green, (the mother of the emeralds), from Egypt.

b. Pale green.

c. White.

This occurs very frequently in the fcaly limeftones; and its colour changes from deep green to white, in proportion as it contains more or lefs of iron.

128 3. Fibrous, ftriated cockle, or fhirl: it looks like fibres or threads made of glafs.

A. Of parallel fibres.

a. Black.

b. Green.

c. White.

B. Of concentrated fibres. The ftarred cockle, or fhirl, from its fibres being laid ftellarwife.

a. Blackifh green, from Salberg, in Weftmanland; where, being found together with a fteel-grained lead ore, the whole is called *grau-ris-malm*, or pine-ore, from its refemblance to the branches of that tree. This kind of cockle is alfo found at Uto in Malaren.

b. Light green.

c. White.

129 4. Cryftallifed cockle, or fhirl.

a. Black.

To this fpecies of cockle, or fhirl, belong moft of thofe fubftances called *imperfect afbefti*; and as the cockle perfectly refembles a flag from an iron furnace, both in regard to its metallic contents and its glaffy texture, it is no wonder that it is not foft enough to be taken for an afbeftus. It has, however, only for the fake of its ftructure, been ranked among the afbefti. The ftriated cockle, or fhirl, compared to the afbefti, is of a fhining and angular furface (though this fometimes requires the aid of the magnifying-glafs to be difcovered), always fomewhat tranfparent, and is pretty eafily brought to a glafs with the blow-pipe, without being confumed as the pure afbefti feem to be.

b. Deep green, from Salberg in Weftmanland.

c. Light green, from Enighets-grufvan at Norberg in Weftmanland.

d. Reddifh brown; from Sorwik at Grengie in Weftmanland, and Glanfhammar in the province of Nerike.

The tauffstein, from Bafil, is of this colour, and confifts of two hexagonal cryftals of cockle grown together in form of a crofs: this the Roman Catholics wear as an amulet, and is called in Latin *lapis crucifer*, or the crofs-ftone.

It is not impoffible that there may be fome kinds of cockles, or fhirls, which, befides iron, alfo contain tin or lead, as the garnets: it has been faid, that lead has been melted out of a cockle, from Rodbeck's Eng at Umea in Lapland; and it feems likewife very probable that the cockles which are found in the Englifh tin-mines may contain fome tin. There are fome cryftals of cockle found which are fufible to a greater degree than any fort of ftone whatfoever: thefe are always of a glaffy texture, and femi-tranfparent.

The figure of the cockle cryftals is uncertain, but always prifmatical: the cockle from Yxfio at Nya Kopparberg, is quadrangular: the French kind has nine fides, or planes; and the tauffstein is hexagonal.

The name *cockle* for thefe fubftances is an old Cornifh mineral name; but is alfo given fometimes to other very different matters.

We have not in England any great quantity of fpecies of cockles; the chief are found in the tin mines of Cornwall, and fome fine cryftallifed kinds have been brought from Scotland.

The Englifh mineral name of *call*, has been ufed by fome authors as fynonymous with *cockles*, and they are confounded together at the mines; but the call, definitely fpeaking, is the fubftance called *wolfram* by the Germans, &c.

Garnets, though fmall, are often found in micaceous ftones in England; but extreme good garnets are found in great plenty alfo in like ftones in Scotland. 130

The Fourth Order.

The *Argillaceous* kind.

The principal character whereby thofe may be diftinguifh from other earths is, that they harden in the fire, and are compounded of very minute particles, by which they acquire a dead or dull appearance when broken.

I. Porcelain

(G) When any of the garnet kind is to be tried for its containing metal, the iron ought to be melted out of it by the common procefs; and if the garnet, at the fame time, contains both tin and lead, thefe two metals are likewife included in the iron: however, they may be extracted out of the iron, by expofing it to a heat augmented by degrees; becaufe then the tin and lead fweat out in form of drops, almoft pure, though always fomewhat mixed with iron.

Argillaceous Earths.

I. Porcelain clay; *Terra porcellanea*, vulgò *Argilla apyra*.

131 This is very refractory in the fire, and cannot in any common ftrong fire be brought into fufion any farther than to acquire a tenacious foftnefs, without lofing its form: it becomes then of a dim fhining appearance and folid texture, when it is broke; ftrikes fire with fteel; and has confequently the beft qualities required as a fubftance whereof veffels capable of refifting a melting and boiling heat, and of holding falts and acids, can be made. It is found,

132 (1.) Pure, *Pura*.

A Diffufible in water.

1. Coherent and dry.

a White. Mr Cronftedt affirms that he has feen a root of a tree changed into this clay.

2. Friable and dry.

a. White.

Thefe may be called *pure*, fince, after being burnt, they are quite white, though they have been expofed to a quick melting heat; and it may be queried, if all fuch clays muft not be fomewhat harfh, or at leaft not unctuous to the touch.

133 (2.) Mixed with phlogifton, and a very fmall quantity of infeparable heterogeneous fubftances. Of thefe are,

A. Diffufible in water.

a. White and fat pipe-clay.

b. Of a pearl colour.

c. Bluifh grey.

d. Grey.

e. Black.

f. Violet.

Thefe contain a phlogifton which is difcovered by expofing them to quick and ftrong fire, in which they become quite black interiorly, affuming the appearance of the common flints, not only in regard to colour, but alfo in regard to hardnefs: but if heated by degrees, they are firft white, and afterwards of a pearl colour. The fatter they feem to be, which may be judged both by their feeling fmooth and unctuous, and by their fhining when fcraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this ftrongly inherent phlogifton be the caufe of the above-mentioned pearl colour, or prevents them from being burnt white in a ftrong fire: yet no heterogeneous fubftance can be extracted from them, except fand, which may be feparated from fome by means of water, but which fand does not form any of the conftituent parts of the clays. If they be boiled in aqua regis in order to extract any iron, they are found to lofe their vifcofity.

134 *B*. Indurated.

Is commonly unctuous to the touch, and more or lefs difficult to be cut or turned in proportion to its different degrees of hardnefs; is not diffufible in water; grows hard, and is very refractory in the fire; pounded and mixed with water, it will not eafily cohere in a pafte: however, if it is managed with care, it may be baked in the fire to a mafs, which, being broke, fhews a dull and porous texture. It takes for the moft part, and without much labour, a fine polifh. It is found,

A. Compact and foft; *Smectis*, Briançon or French chalk. 135

a. White.

b. Yellow.

c. Red and white, and which looks like Caftile foap.

B. Solid and compact fteatites, and alfo foap-rock. 136

a. White or light green. *b*. Deep green *c*. Yellow.

It is a very difficult matter to fpecify all the varieties of the foap-ftones in regard to their hardnefs or foftnefs, fince they cannot be compared with any ftandard meafure. Thofe from Rifver, Sikfioberg, and China, are a great deal harder and more folid than the Englifh kind from the Land's End, which breaks between the fingers; but are foft in comparifon to that from Salberg, which is there called *ferpentine*, although both thefe varieties may indifcriminately be made ufe of for cutting and turning. The foft ones, however, are not fo apt to crack, when they are worked, as the harder. But none of thefe varieties is found in the rock, without being interfperfed with the unctuous clefts. When they are too many, too clofe to one another, and make the ftone unfit for ufe, they are in this cafe called by the Swedifh miners, *Skiolige;* and of this kind is a great quantity found at Salberg and Swartwik. Moft part of the foap-rock which is found in Sweden, is likewife mixed with glimmer or mica; and then it is called *telgften*, that is, *ollaris*.

C. Solid, and of vifible particles; ferpentine ftone. 137

1. Of fibrous and coherent particles. This is compofed, as it were, of fibres; and might therefore be confounded with the afbeftus, if its fibres did not cohere fo clofely with one another as not to be feen when the ftone is cut and polifhed. The fibres themfelves are large, and feem as if they were twifted.

a. Deep green. This is fold for the *lapis nephriticus*, and is dug at fome unknown place in Germany.

b. Light green from Skienfhyttan, in Weftmanland; in Sweden it is ufed by the plate-fmiths inftead of the French chalk.

2. Fine-grained ferpentine ftone: the Zoeblitz ferpentine. 138

a. Black. *b*. Deep green. *c*. Light green, *d*. Red. *e*. Bluifh grey. *f*. White. Thefe colours are all mixed together in the ferpentine ftone from Zoeblitz, but the green is the moft predominant colour.

(3.) Mixed with iron. This is, 148

A. Diffufible in water.

a. Red. Some of the bricks which are imported

ported from certain places in Germany, seem to be made of this kind.

B. Indurated.

1. Martial soap-earth; *Creta Brianzonica martialis.*
   a. Red, and mixed with some calcareous matter.
2. Martial soap-rock; *Steatites martialis.*
   a. Black. *b.* Red.

140 II. Stone-marrow; *Lithomarga.* *Keffekil* of the Tartars.

1. When dry, it is as fat and slippery as soap: but,
2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger bits, or resembles a curd like mass.
3. In the fire it easily melts to a white or reddish frothy slag, consequently is of a larger volume than the clay was before being fused.
4. It breaks into irregular scaly pieces.

A. Of coarse particles: Coarse stone-marrow.

a. Grey, from Osmundsberget, in the parish of Rettwik, in Dalarne; and is there called *walklera*, that is, fuller's earth. It is mentioned in an account of Osmundsberget, published in the Transactions of the Academy of Sciences at Stockholm, in the year 1739, by the berg's-radet, or mine-master, Mr Tilas.

b. Whitish yellow, from the Crim Tartary, where it is called *keffekil*, and is said to be used for washing instead of soap.

B. Of very fine particles; fine stone-marrow.

a. Yellowish-brown; *Terra Lemnia.*—Is of a shining texture, falls to pieces in the water with a crackling noise; it is more indurated than the preceding, but has otherwise the same qualities.

141 III. Bole.

Is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specifical qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, contrary to what the porcelain and the common clays are, (I. & V.); but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the loadstone.

142 *A.* Loose and friable boles, or those which fall to a powder in water.

a. Flesh-coloured bole.

b. Red.

1. Fine; *Bolus Armenus.*
2. Coarse; *Bolus communis officinalis.*
3. Hard; *Terra rubrica.*

c. Green; *Terre verte.*

1. Fine.
2. Coarse.

d. Bluish-grey, is ductile as long as it is in the rock, but even then repels the water; it contains 40 per cent. of iron; which metal being melted out of it in a close vessel, the iron crystallises on its surface.

e. Grey.

1. Crystallised in a spherical polygonal figure.
2. Of an undeterminate figure.

At the time when the *terræ sigillatæ*, or sealed earths, were in general use, the druggists endeavoured to have them of all colours, and for that reason they took all sorts of clays, and sealed them: not only the natural ones, but likewise such as had been coloured by art, or had been mixed with *magnesia alba officinalis*, or other things, were afterwards vended for true boles; and for this reason the species of boles is still thought to comprehend so many varieties. Thus the Cologne clay is by the druggists ranked among the white sealed earths, and is called a *white bole:* and this same clay is by the Swedish potters called *Englesk jord*, or English earth; and by the tobacco-pipe makers *pip-lera*, or pipe-clay, &c.: which shews how great a confusion there must ensue, if the knowledge of these bodies was not founded upon a surer ground than the colour, figure, and names invented by common mechanics. Since the most part of these *terræ sigillatæ*, or sealed earths, are found to contain iron, we may conclude that the bole must be a martial clay; and, as such, it seems to be more fit for medical uses than other clays, if any dead earth must be used internally, when there is such an abundance of finer substances.

B. Indurated bole. 143

A. Of no visible particles.

This occurs very often in form of slate, or layers, in the earth; and then is made use of as an iron ore. However, it has usually been considered more in regard to its texture than to its constituent parts; and has been called *slate*, in common with several other earths which are found to have the same texture.

a. Reddish-brown; in most collieries, between the seams of coal.

b. Grey; from Coalbrookdale in Shropshire, and most collieries of England.

B. Of scaly particles.—The hornblende of the Swedes. 144

Is distinguished from the martial glimmer, or mica, by the scales being less shining, thicker, and rectangular.

a. Black.—This, when rubbed fine, gives a green powder.

b. Greenish.

Both these, particularly the black, are found every-where in Sweden among the iron-ores, and in the Grunsten. The hornblende grows hard in the fire, which is the reason why it is ranked here among the clays, though in all its other qualities it much resembles the cockle or shirl.

IV. Tripoli. *Terra Tripolitana.*

Is known by its quality of rubbing hard bodies, and making their surfaces to shine; the particles of the tripoli being so fine as to leave even no scratches on the surface. This effect 145

effect, which is called *polifhing*, may likewife be effected by other fine clays when they have been burnt a little. The tripoli grows fomewhat harder in the fire, and is very refractory: it is with difficulty diffolved by borax, and ftill with greater difficulty by the microcofmic falt. It becomes white when it is heated: when crude, it imbibes water, but is not diffufible in it: it taftes like common chalk, and is rough or fandy between the teeth, although no fand can by any means be feparated from it. It has no quality common with any other kind of earth, by which it might be confidered as a variety of any other. That which is here defcribed is of a yellow colour, and is fold by druggifts. This kind of tripoli has been lately difcovered in Scotland. But the *rotten-ftone*, fo called, is another fort found in England, viz. in Derbyfhire. It is in common ufe in England among workmen for all forts of finer grinding and polifhing, and is alfo fometimes ufed by lapidaries for cutting of ftones, &c.

146 V. Common clay, or brick clay. *Argilla communis; vulgaris plaftica.*

This kind may be diftinguifhed from the other clays, by the following qualities.

1. In the fire it acquires a red colour, more or lefs deep.
2. It melts pretty eafily into a greenifh glafs.
3. It contains a fmall quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

A. Diffufible in water.

1. Pure.
   - *a.* Red clay.
   - *b.* Flefh-coloured, or pale-red.
   - *c.* Grey.
   - *d.* Blue.
   - *e.* White, is found in the woody parts of Sodermanland, Dalarne, and of other provinces. It is often found in a flaty form, with fine fand between its ftrata. It is not eafy to be baked in the fire: when it it burnt, it is of a pale-red colour, and is more fufible than the preceding ones.
   - *f.* Fermenting clay. *Argilla intumefcens.*

     This is very like the preceding, as to the external appearance and other qualities; but when they are both found in the fame place, which is not uncommon in feveral of our mine countries, they feem to be different in regard to the fermenting quality of this variety. This fermentation cannot be the effect of the fand mixed with it, becaufe fand is found in them both: and befides, this kind ferments in the fame manner when it is mixed with gravel or ftones; and then it ferments later in the fpring than the other, fince by the ftones, perhaps, the froft is longer retained in it.
2. Mixed with lime. See MARLE, n° 95.

B. Indurated.

1. Pure. 147
   - *a.* Grey flaty.
   - *b.* Red flaty, from Kinnekulle, in the province of Weftergottland.
2. Mixed with phlogifton, and a great deal of the vitriolic acid. See ALUM *Ores*, n° 173.
3. Mixed with lime; (n° 98).

The FIFTH ORDER.

THE *Micaceous* kinds. The glimmer, daze, or glift. 148

Thefe are known by the following characters.

1. Their texture and compofition confift of thin flexible particles, divifible into plates or leaves, having a fhining furface.
2. Thefe leaves, or fcales, expofed to the fire, lofe their flexibility, and become brittle, and then feparate into thinner leaves: but in a quick and ftrong fire, they curl or crumple, which is a mark of fufion; though it is very difficult to reduce them into a pure glafs by themfelves, or without addition.
3. They melt pretty eafily with borax, the microcofmic falt, and the alkaline falt; and may, by means of the blow-pipe, be brought to a clear glafs with the two former falts. The martial mica is, however, more fufible than the uncoloured ones.

There is not yet difcovered any loofe earth of this kind, but it is always found indurated.

A. Colourlefs or pure mica; daze, glimmer, or glift. 149

1. Of large parallel plates; Mufcovy glafs. Is tranfparent as glafs; found in Siberia, and Elfdalen in the province of Wermeland in Sweden. 2. Of fmall plates; from Silfverberget, at Runneby, in the province of Blekinge, in Sweden. 3. Of particles like chaff; chaffy mica. 4. of twifted plates; crumpled mica.

B. Coloured and martial glimmer.

1. Of large parallel plates; *Martialis.* 150
   - *a.* Brown femi-tranfparent.
2. Of fine and minute fcales.
   - *a.* Brown.
   - *b.* Deep green.
   - *c.* Light green; *Talcum officinale.*
   - *d.* Black, found in granites.
3. Twifted or crumpled glimmer.
   - *a.* Light green, in the olaris.
4. Chaffy glimmer.
   - *a.* Black, is found in the ftone called *hornberg*, which occurs in moft of the Swedifh coppermines.
5. Cryftallifed glimmer; *Mica drufica.*
   1. Of concentrated and erect fcales.
   2. Of hexagonal horizontal plates.

The SIXTH ORDER.

The fluors, *Fluores minerales.* Suec. *Fluff-arter.* Germ. *Fluff-arten.* 151

Thefe are commonly called *fluxing*, *vitrefcent*, or *glafs fpars*, becaufe moft part of them have a fparry from

EARTHS. Fluors. form and appearance: they are, however, often met with in an indeterminate figure.

These are only known in an indurated state; and distinguish themselves from the other earths by the following characters.

1. They are scarce harder than a calcareous spar, and consequently do not strike fire with steel.
2. They do not ferment with acids, neither before nor after calcination, notwithstanding a phlogiston or an alkali had been added in the calcination.
3. They do not melt by themselves, but only split to pieces when exposed to a strong fire. But,
4. In mixtures with all other earths, they are very fusible, and especially when they are blended with the calcareous earth, with which they melt to a corroding glass, which dissolves the strongest crucibles, unless some quartz or apyrus clay is added thereto.
5. When heated slowly, and by degrees, they give a phosphorescent light; but as soon as they are made red-hot, they lose this quality. The coloured ones, and especially the green, give the strongest light, but none of them any longer than whilst they are well warm.
6. They melt and dissolve very easily by the addition of borax, and next to that by the microcosmic salt, without ebullition.

152 *A.* Indurated fluor.

(1.) Solid, of an indeterminate figure. Is of a dull texture, semi-transparent, and full of cracks in the rock.
 a. White.

(2.) Sparry fluor has nearly the figure of spar, though, on close observation, it is found not to be so regular, nothing but the glossy surface of this stone giving it the resemblance of spar.
 a. White. *b.* Blue. *c.* Violet. *d.* Deep green. *e.* Pale green. *f.* Yellow, from Gislof in Skone.

153 (3.) Crystallised fluor, when in single crystals; but fluor druse, when many crystals are heaped together.
 1. Of an irregular figure.
  a. White. *b.* Blue. *c.* Red.
 2. Of a cubical figure.
  a. Yellow. *b.* Violet.
 3. Of a polygonal spherical figure.
  a. White. *b.* Blue.
 4. Of an octoëdral figure.
  a. Clear and colourless.

The Seventh Order.

154 The *Asbestus* kind; *Asbestinæ*.

These are only yet discovered in an indurated state: their characters are as follow,

1. When pure they are very refractory in the fire. 2. In large pieces they are flexible. 3. They have dull or uneven surfaces. 4. In the fire they become more brittle. 5. They do not strike fire with the steel. 6. They are not attacked by acids. 7. They are easily brought into fusion by borax.

2

EARTHS. Asbestus, Zeolites. In this order are included both those varieties which by fossilogists have been mentioned under the names *amianti* and *asbesti*, and have often been confounded together.

I. Asbestus which is compounded of soft and thin membranes; *Amiantus Wallerii*. 155
 A. Of parallel membranes; *Corium*, sive *caro montana*, mountain-leather.
  1. Pure.
   a. White.
  2. Martial.
   a. Yellowish brown, from Storrginningen, at Dannemora, in the province of Upland. This melts pretty easily in the fire to a black slag, or glass.
 B. Of twisted soft membranes, mountain-cork. 156
  1. Pure.
   a. White.
  2. Martial.
   a. Yellowish brown. This has the same quality in the fire as the martial mountain-leather.

II. Of fine and flexible fibres; *Asbestus*, or earth-flax; *Asbestus Wallerii*. 157
 A. With parallel fibres; *Byssus*.
  1. Pure and soft.
   a. Light green.
   b. White.
  2. A little martial, and more brittle.
   a. Greenish; from Bastnas Grufva, at Ryddarhyttan in Westmanland in Sweden. There it forms the greatest part of the vein out of which the copper ore is dug; a great part of it is consequently melted together with the ore, and is then brought to a pure semi-transparent martial slag or glass.
 B. Of broken and recombined fibres. 158
  1. Martial.
   a. Light green.

The Eighth Order.

Zeolites.

This is described in its indurated state, in the Transactions of the Academy of Sciences at Stockholm for the year 1756; and there methodised as a stone *sui generis*, in regard to the following qualities: 159

1. It is a little harder than the fluors, and the calcareous kind: it receives however scratches from the steel, but does not strike fire with it.
2. It melts easily by itself in the fire, with a like ebullition as borax does, into a white frothy slag, which not without great difficulty can be brought to a solidity and transparency.
3. It is easier dissolved in the fire by the mineral alkali *(sal sodæ)*, than by the borax and microcosmic salt.
4. It does not ferment with this last salt, as the lime does; nor with the borax, as those of the gypseous kind.
5. It dissolves very slowly, and without any effervescence, in acids, as in oil of vitriol and spirit of nitre. If concentrated oil of vitriol is poured on pounded zeolites, a heat arises, and the

EARTHS. *Zeolites.*

powder unites into a mafs (1).

6. In the very moment of fufion it gives a phofphorus or light.

160 The zeolites is found in an indurated ftate.

(1.) Solid, or of no vifible particles.

A. Pure; *Zeolites durus.*

a. White, from Iceland.

B. Mixed with filver and iron.

a. Blue; *Lapus lazuli,* from the Buckarian Calmucks. This, by experiments made with it, has difcovered the following properties:

1. It retains for a long time its blue in a calcining heat, but is at laft changed into a brown colour.

2. It melts eafily in the fire to a white frothy flag; which, when expofed to the flame of a blow-pipe, is greatly puffed up, but in a covered veffel, and with a ftronger heat, becomes clear and folid, with blue clouds in it.

3. It does not ferment with acids: but,

4. Boiled in oil of vitriol, it diffolves flowly, and lofes its blue colour.

When a fixed alkali is added to this folution, a white earth is precipitated, which being fcorified with borax, yields a filver regulus, that varies in bignefs according to the various famples of the ftone.

5. By fcorification with lead, there has been extracted two ounces of filver out of 100 pounds weight of the ftone.

6. The prefence of filver is not difcovered with the fame certainty by the fpirit of nitre as by oil of vitriol.

7. When the fpirit of fal ammoniac is added to any folution, made either of crude or of a perfectly calcined lapis lazuli, there is no blue colour produced; which proves that this colour is not owing to copper, as fome have pretended: and this is farther confirmed by the fixity of the blue colour in the fire (1, 2.), and by the colour of the flag or glafs (2).

8. It is a little harder than the other kinds of zeolites; but does not, however, in hardnefs approach to the quartz, or to other ftones of the filiceous kind in general; becaufe the pureft and fineft blue lapis lazuli may be rubbed with the fteel to a white powder, although it takes a polifh like marble.

9. The lapis lazuli, when perfectly calcined, is a little attracted by the loadftone; and fcorified with lead, the flag becomes of a greenifh colour, not fuch a colour as copper gives, but fuch as is always produced by iron mixed with a calcareous fubftance.

161 (2.) Sparry zeolites.

This refembles a calcareous fpar; though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured; from Nya Krongrufvan, one of the gold-mines at Adelfors, in the province of Smoland.

EARTHS. *Magnefiæ.*

162 (3.) Cryftallifed zeolites is more common than the two preceding kinds; and is found,

A. In groups of cryftals in form of balls, and with concentrical points.

a. Yellow.

b. White.

B. Prifmatical and truncated cryftals.

a. White.

C. Capillary cryftals are partly united in groups, and partly feparate. In this latter accretion they refemble the capillary or feather filver ore; and is perhaps fometimes called *flos ferri,* at places where the nature of that kind of ftone is not yet fully known.

Thefe cryftals are found,

a. White.

The Ninth Order.

The *Manganefe* kind; *Magnefiæ.*

The ftones belonging to this order are in Swedifh called *brunften,* in Latin *fyderea,* or *magnefiæ nigræ;* in order to diftinguifh them from the *magnefia alba officinalis,* and in French *mangonefe,* &c. They are by fome lithographifts entirely omitted, and by others ranked among the iron ores. 163

1. The manganefes confift of a fubftance which gives a colour both to flags and to the folutions of falts, or, which is the fame thing, both to dry and to liquid menftrua, *viz.*

a. Borax, which has diffolved manganefe in the fire, becomes tranfparent, of a reddifh brown or jacinth colour. *b.* The microcofmic falt becomes tranfparent with it, of a crimfon colour, and moulders in the air. *c.* With the fixed alkali, in compofitions of glafs, it becomes violet; but if a great quantity of manganefe is added, the glafs is in thick lumps, and looks black. *d.* Scorified with lead, the glafs gets a reddifh brown colour. *e.* The lixivium of a deflagrated manganefe is of a deep red colour.

2. It deflagrates with nitre, which is a proof that it contains fome phlogifton.

3. When reckoned to be light, it weighs as much as an iron ore of the fame texture.

4. Being melted together with glafs-compofitions, it ferments during the folution: but it ferments in a ftill greater degree when it is melted with the microcofmic falt.

5. It does not excite any effervefcence with the fpirit of nitre: aqua regia, however, extracts the colour out of the black, and diffolves likewife a great deal of it, which, by means of an alkali, is precipitated to a white powder.

6. Such colours as are communicated to glaffes by manganefe, are eafily deftroyed by the calx of arfenic or tin: they alfo vanifh of themfelves in the fire.

7. It is commonly of a loofe texture, fo as to colour the fingers like foot, although it is of a metallic appearance when broke.

Manganefe

(1) Other varieties of the zeolites have been difcovered, particularly at Adelfors's gold-mines in Smoland in Sweden; of which fome forts do not melt by themfelves in the fire, but diffolve readily in the acid of nitre, and are turned by it into a firm jelly.

Manganese is found,

A. Loose and friable,

164 *a.* Black, seems to be decayed particles of the indurated kind.

165 *B.* Indurated.

1. Pure, in form of balls, whose texture consists of concentric fibres.

a. White, *Magnesia alba strictè sic dicta*, is very scarce. Mr Cronstedt saw a specimen of this kind in a collection from an unknown place in Norway; and by examining a piece of it, he found that it differed from the common manganese, by giving to the borax a deep red colour in the fire: this sort acquires a reddish brown colour when it is calcined.

b. Red manganese is said to be found in Piedmont. This Mr Cronstedt has never seen; but has been told that this variety is free from iron, and gives to glass rather a red than a violet colour.

166 2. Mixed with a small quantity of iron.

a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses and by the potters. It is found,

1. Solid, of a flaggy texture; *Magnesia textura vitrea.*
2. Steel-grained.
3. Radiated.
4. Crystallised.

a. In form of coherent hemispheres.

167 3. Blended with a small quantity of iron and tin; *Spuma lupi*, or *Wolfram.*

Wolfram is a name which is also sometimes given to mock lead, and sometimes to cockle or shirl, as also to other minerals; however, it is chiefly given to this species of manganese, when it occurs in the tin mines.

1. With coarse fibres.

a. Of an iron colour. This gives to the glass compositions, and also to borax and the microcosmic salt, an opaque whitish yellow colour, which at last vanishes.

SECOND CLASS.

168 The SALTS. By this name those mineral bodies are called which can be dissolved in water, and give it a taste; and which have the power, at least when they are mixed with one another, to form new bodies of a solid and angular shape, when the water in which they are dissolved is diminished to a less quantity than is required to keep them in solution; which quality is called *crystallisation.*

No other salts ought to be considered and ranked in a mineral system but those which are found natural in the earth; and for this reason a great number of salts will be in vain looked for here, viz. all such as are either natural or prepared by art in the other two kingdoms of nature, and from substances belonging to them. Amongst these is nitre itself and its acid, and the vegetable acid, since these are never had from true mineral bodies; nor is it demonstrated that they have their origin from the true mineral vitriolic and muriatic acids. There have, indeed, been many attempts made to reduce most of them to a vitriolic acid, which by many is called the *universal acid:* but experiments will not agree with it; at least nobody has yet been able, by uniting a phlogiston with any other acid than the true vitriolic, to produce a substance in every particular resembling the true brimstone, or sulphur.

In regard to the known principal circumstances or qualities of the mineral salts, they are divided into

1. Acid salts, or mineral acids.
2. Alkaline salts, or mineral alkalis.

The First Order.

Acid salts; the characters of which are, that they 169

1. Have a sour taste.
2. Are corrosive; that is to say, have a power of dissolving a great number of bodies.
3. They have a strong attraction to the alkaline salts and earths, whence they always unite with them with an effervescence, and sometimes with a strong heat: by this mixture bodies are produced, which are employed in common life under the names of *vitriols*, *neutral salts*, *gypsum*, &c.
4. They change most of the expressed blue juices of vegetables into red.
5. They separate the alkali from the fat, when they have been united in soap; which effect is called *curdling* or *coagulation.*
6. They are volatile and subtile, so as never to be observable by the naked eye, unless they are mixed with heterogeneous bodies; and therefore the figure of the pure mineral acids cannot be defined but by guess.

A. The vitriolic acid; *Acidum vitrioli, aluminis, et sulphuris.* 170

I. The pure vitriolic acid is, in abstract, considered as possible to occur in nature: its qualities, when mixed with water, in which it is caught by distillation, are as follows:

1. When mixed with the least possible quantity of water, it is of an unctuous appearance, and is for that reason improperly called *oil of vitriol.*
2. It has in that state a considerable heaviness, viz. in comparison to water, as 1700 to 1000.
3. It dissolves silver, tin, the regulus of antimony, and quicksilver; but,
4. When mixed with more water, it dissolves zinc, iron, and copper.
5. It dissolves likewise the calcareous earth, and precipitates with it in form of a gypsum, of which a part shoots into gypseous drusen, *selenites et crystalli gypsei.*
6. It unites with the earth of quartz, when it has been previously dissolved in the *liquor silicum;* and with a pure argillaceous earth, dissolving it without any fermentation: with both these earths it makes alum.
7. It has a stronger attraction to the inflammable substance than to the alkaline salt, and forms with it a body which properly may be called the *mineral sulphur.*
8. When it is perfectly united with phlogistic substances belonging to the vegetable kingdom,

dom, and the water has been completely separated, this mixture catches flame in the open air, and is consumed; as may be seen by the powder called *pyrophorus*.

9. It attracts water strongly, and the aqueous vapours out of the air; and if a great quantity of water is added to it at once, a strong heat arises.

10. It unites readily and easily with the alkalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *tartarus vitriolatus*, *sal mirabile*, and *sal ammoniacum fixum*.

171 II. The vitriolic acid mixed or saturated.

A. With metals; *Vitriola*, vitriols.

a. Simple vitriols.

1. Martial vitriol; green vitriol, or copperas.

This is the common green vitriol, which naturally is found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

2. Copper vitriol; blue vitriol. This is of a deep blue colour, and is found in all ziment waters, as they are called; for instance, at Neusohl in Hungary, in St Johan's mine at Fahlune in the province of Dalarne, at Nya Kopparberget in Westmanland, and the copper-mines at Wicklow in Ireland, &c. It is, however, seldom perfectly free from an admixture of iron and zinc.

3. Zinc vitriol, is white and clear as alum, and is found at the Ramelsberg in the Hartz, as also in the rubbish at Stollgrufvan in Westmanland in Sweden, where the mock lead has decayed either spontaneously, or after having been burnt.

172 *b*. Compound vitriols.

1. Vitriol of iron and copper, is of a bluish green colour.

2. Vitriol of iron, zinc, and copper. This verges more to the blue than to the green colour. It is made at Fahlune in Dalarne, from the water which is pumped out of the copper mines: in this water large crystals of vitriol are often ready formed. If this vitriol is dipped in water, and afterwards rubbed on clean iron, the copper does not precipitate from it.

3. Vitriol of zinc and iron. This is the green vitriol from Goslar in the Hartz.

4. Vitriol of zinc and copper. This is the blue vitriol from Goslar.

5. Vitriol of nickel and iron, is of a deep green colour, and is contained in the ochre or decayed parts of the nickell, at the cobalt-mines at Los, in the province of Helsingland.

Most part of the vitriols owe their formation to art: because when such ores as contain sulphur are dug out of the mines by means of fire, the phlogiston of the sulphur is by the heat expelled, leaving the acid behind; which, being let loose or freed, is thereby enabled to attract and unite with watery vapours, dissolving at the same time the metals; and it is thus the vitriols are formed. Every sort of ore does not commonly decay or weather in a natural manner, without being promoted by art; and this decaying or weathering is mostly performed in the open air: for which reason no very great quantity of vitriol can be expected in that way; for when any ore thus weathers or decays, the dissolved particles are by degrees carried off by the rain, and are at last found in a dissolved state in certain springs or mineral waters. All such ores may therefore be called *true vitriol ores*, as contain iron, copper, zinc, and nickel mineralised with sulphur. The acid in the vitriols, however, is not dulcified by the metals, as it is by the alkali in the true neutral salts.

B. The acid of vitriol mixed or saturated with earths. 173

1. With a calcareous earth. Gypsum.

2. With an argillaceous earth. The alum kind.

a. With a small quantity of clay. Native or plumose alum.

Is found on decayed alum ores in very small quantities.

The gypsa and asbesti, but more especially the latter, have been used through ignorance in most countries for plumose native alum, on account of the similarity of structure.

b. With a greater quantity of pure clay. White alum ore.

1. Indurated pale red alum ore. Is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale red alum called *roche-alum*. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it does not show the least marks of any metallic substance.

c. With a very large quantity of martial clay, which likewise contains an inflammable substance. Common alum ore.

Is commonly indurated and slaty, and is therefore generally called *alum slate*.

It is found,

1. Of parallel plates, with a dull surface; from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c.

2. Undulated and wedge-like, with a shining surface. This at first sight resembles pit-coal: it is found in great abundance in the parish of Nas in Jemtland.

C. Vitriolic acid united with phlogiston. The sulphur kind. 174

D. Vi-

D. Vitriolic acid ſaturated with alkaline ſalt.

a. With the alkali of the common ſalt or ſea-ſalt.

175 This is a neutral ſalt, prepared by natute as well as by art, containing more or leſs of iron, or of a calcareous earth, from which ariſes alſo ſome difference in its effects when internally uſed. It ſhoots eaſily into priſmatical cryſtals, which become larger in proportion to the quantity of water evaporated before the cryſtalliſation. When laid on a piece of burning charcoal, or elſe burnt with a phlogiſton, the vitriolic acid diſcovers itſelf by the ſmell like to the *hepar ſulphuris*.

It is found in a diſſolved ſtate in ſprings and wells, and in a dry form on walls, in ſuch places where aphronitrum has effloreſced through them, and the vitriolic acid has happened to be preſent; for inſtance, where marcaſites are roaſted in the open air. This ſalt is often confounded with the aphronitrum, or a pure mineral alkali; and a learned diſpute once aroſe, which of theſe ſalts ought with the greateſt propriety to be called *natron*, *Baurach veterum*, *ſal mirabile*, or *Epſom ſalt*; whereas it might eaſily have been decided by chemical experiments, if their qualities had been regarded in preference to their figures or their native places.

This may be called *Engliſh* or *Epſom ſalt*, when it has naturally as equal a copious portion of the calcareous earth as of the artificial one; but in regard to its effects, for which it has been moſt valued by Glauber, Mr Cronſtedt has ranked all the leſs conſiderable varieties of this neutral ſalt, when natural, under the name of *ſal mirabile*.

176 *B*. Acid of common or ſea-ſalt. This acid, conſidered in that ſtate in which it can be had, viz. in mixture with water, has the following qualities:

1. It does not alter the fluidity of water, nor conſiderably augment its heavineſs, as the vitriolic acid does.
2. It is ſomewhat leſs corroſive and ſour than the ſaid vitriolic acid.
3. It ſtrongly attracts the alkaline ſalts; but, however, is forced to quit them to the vitriolic acid, when that is added.
4. It diſſolves the calcareous earth, and makes with it a ſubſtance called *ſal ammoniacum fixum*.
5. When expoſed to the fire, combined with a phlogiſton, it burns with a yellowiſh green flame.
6. When highly concentrated and pure, as when it is diſtilled from common ſalt mixed with pipe-clay, it diſſolves tin and lead: but leſs pure, it diſſolves copper, iron, zinc, and the regulus of antimony: the copper is, however, more eaſily diſſolved when it is in form of a calx, as the calces of quickſilver and cobalt likewiſe are.
7. It unites with ſilver diſſolved in aquafortis, and with lead diſſolved in aqua-regia, falling with them to the bottom in form of a white ſpongy maſs. This precipitation, expoſed to the fire, ſtill retains the acid, and melts with it into a glaſſy ſubſtance, which does not diſſolve in water.
8. It is apt to attract the humidity of the air, and to promote the decaying of thoſe dry ſubſtances with which it has been united.
9. Mixed with the ſpirit of nitre, it makes the ſolution called *aqua-regia*, which is the true liquid menſtruum for gold.

This acid ſeems alſo, on certain occaſions, to have got looſe from thoſe ſubſtances with which it had been originally united in the earth: the *ſal ammoniacum naturale* at Solfatara in Italy, and the horn ſilver ore, appear to be proofs of this, as they ſeem to be the products of time.

I. Mixed or ſatiated acid of ſea-ſalt.

A. With earths. 177

1. With a calcareous earth; *ſal ammoniacum fixum*.

This ſomewhat decays, or attracts the humidity of the air: it is found in abundance in the ſea-water. See the calcareous kind, (91, &c.)

B. With alkaline ſalts. 178

(1.) With the fixed mineral alkali, or ſea alkali; common ſalt, or ſea-ſalt.

This ſhoots into cubical cryſtals during the evaporation; it crackles in the fire, and attracts the humidity of the air.

α. Rock ſalt, foſſil ſalt.

Occurs in form of ſolid ſtrata in the earth.

1. With ſcaly and irregular particles.
   - *a*. Grey, and
   - *b*. White. Theſe are the moſt common, but the following are ſcarcer:
   - *c*. Red,
   - *d*. Blue, and
   - *e*. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.
2. Cryſtalliſed rock-ſalt.
   - *a*. Tranſparent, from Cracow in Poland, &c.

β. Sea-ſalt.

Is produced from ſea-water, or from the water of ſalt lakes, by evaporation in the ſun, or by boiling.

The ſeas contain this ſalt, though more or leſs in different parts. In Siberia and Tartary, there are lakes that contain great quantities of ſalt.

γ. Spring-ſalt.

(2.) Saturated with a volatile alkali. Native ſal. ammoniac.

This is of a yellowiſh colour, and is ſublimed from the flaming vents or crevices at the Solfatara near Naples.

C. United with phlogiſton; amber, *ſuccinum*. 179

D. United with metals. 180

1. With ſilver; *Minera argenti cornea*, horn ſilver ore. The *hornertz* of the Germans.

The SECOND ORDER.

ALKALINE mineral ſalts.

Theſe are known by their action on the above-mentioned acids when they are joined together, whereby 181

whereby a fermentation arifes, and a precipitation enfues of fuch bodies as either of them had before kept in diffolution, uniting at the fame time together; by which new compofitions are made, that are called *neutral falts*, or *falia neutra*.

Thefe alkaline falts are,

182 I. Fixed in the fire.

A. Alkali of the fea, or of common falt.

(1.) Pure.

This has nearly the fame qualities with the lixivious falt which is prepared from the afhes of burnt vegetables; it is the fame with the *fal fodæ*, or kelp, becaufe the kelp is nothing elfe than the afhes remaining after the burning of certain herbs that abound with common falt; but which common falt, during the burning of thofe vegetables, has quitted its acid.

This,

1. Ferments with acids, and unites with them.
2. Turns the fyrup of violets to a green colour.
3. Precipitates fublimate mercury in an orange-coloured powder.
4. Unites with fat fubftances to make foap.
5. Diffolves the filiceous earth in the fire, and makes glafs with it, &c. It diftinguifhes itfelf from the falt of the pot-afhes, by the following properties: that,
6. It fhoots eafily into prifmatical cryftals; which
7. Fall to powder in the air, in confequence of their eafily lofing their humidity.
8. Mixed with the vitriolic acid, it makes the *fal mirabile*.
9. It melts eafier; and perhaps it is alfo more conveniently applied in the preparation of feveral medicines.
10. It is fomewhat volatile in the fire.

183 (2.) Mixed with a fmall quantity of the calcareous earth.

This is fo ftrongly united with the calcareous earth, that the latter enters with it into the very cryftals of the falt: though, by repeated folutions, the earth is by degrees feparated from it, and falls to the bottom after every folution. It grows in form of white froft on walls, and under vaults, and in places where it cannot be wafhed away by the rain. When it contains any confiderable quantity of the calcareous earth, its cryftals become rhomboidal, a figure which the calcareous earth often affumes in fhooting into cryftals; but when it is purer, the cryftals fhoot into a prifmatical figure. This is a circumftance which neceffarily muft confufe thofe who know the falts only by their figure, and fhews at the fame time how little certainty fuch external marks afford in a true diftinction of things. This falt is therefore very often confounded with the *fal mirabile*.

184 (3.) Saturated with mineral acids. Neutral falts.

a. With the acid of fea-falt; common falt, fea-falt.

b. With the vitriolic acid; *fal mirabile*.

B. Borax. 185

Many experiments have been made with this falt, in order to difcover its origin and conftituent parts, the moft remarkable of which are mentioned under the article CHEMISTRY n° 170, and its following qualities are to be obferved.

1. It fwells and froths in the fire, as long as any humidity remains in it; but melts afterwards very eafily to a tranfparent glafs, which, as it has no attraction to the phlogifton, keeps itfelf in the form of a pearl on the charcoal when melted with the blow-pipe.
2. It changes the fyrup of violets into green; and precipitates the folution of alum, and that of metals made with acids.
3. It unites with mineral acids to a neutral falt, which fhoots into very fine and fubtile hair-like cryftals, and is called *fal fedativum*. In a certain compofition it is volatile; and mixed with *litmus*, or *fuccus heliotropii*, and the fyrup of violets, it difcovers marks both of an alkali and an acid.
4. When it has been united with the vitriolic acid and a phlogifton, no *hepar fulphuris* is produced.
5. After being refined, it fhoots into irregular figures: but the cryftals, which form themfelves after the firft operation, and are called *tincal*, confift of octagonal prifms, flat at the extremities, and with their angles cut off or truncated.

II. Volatile. This perfectly refembles that falt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *fal urinofum*, and is commonly confidered as not belonging to the mineral kingdom; but fince it is difcovered not only in moft part of the clays, but likewife in the fublimations at Solfatara near Naples, it cannot poffibly be quite excluded from the mineral kingdom. 186

Its principal qualities are, That,

a. In the fire it rifes in a dry form, and volatilifes in the air in form of corrofive vapours, which are offenfive to the eyes and nofe.

b. It precipitates the folution of the mercurial fublimate into a white powder.

c. It alfo precipitates gold out of *aqua regia*, and detonates with it.

d. It has a reaction in regard to the acids, tho' not fo ftrongly as other alkalies.

e. It tinges the folution of copper blue, and diffolves this metal afrefh, if a great quantity is added.

f. It deflagrates with nitre, which proves that it contains a phlogifton.

It is never found pure; but,

A. Mixed, 187

1. With falts.

a. With the acid of common falt. Native fal ammoniac.

2. With earths.

a. Clay.

INFLAMMABLES. Ambergrife, Amber.

a. Clay. The greateft part of the clays contain a volatile alkali, which difcovers itfelf in the diftillation of the fpirit of fea-falt, &c.

THIRD CLASS.

188 Mineral INFLAMMABLE SUBSTANCES.

To this clafs belong all thofe fubterraneous bodies that are diffoluble in oils, but not in water, which they repel; catch flame in the fire; and are electrical.

It is difficult to determine what conftitutes the difference between the purer forts of this clafs, fince they all muft be tried by fire, in which they all yield the fame product; but thofe which in the fire fhew their differences by containing different fubftances, are here confidered as being mixed with heterogeneous bodies: that fmall quantity of earthy fubftance, which all phlogifta leave behind in the fire, is, however, not attended to.

189 I. Ambergrife, is commonly reckoned to belong to the mineral kingdom, although it is faid to have doubtful marks of its origin.

a. It has an agreeable fmell, chiefly when burnt.

b. It is confumed in an open fire.

c. It foftens in a gentle degree of heat, fo as to ftick to the teeth like pitch.

d. It is of a black or grey colour, and of a dull and fine-grained texture. The grey is reckoned the beft, and is fold very dear.

190 II. Amber. *Ambra flava; fuccinum; electrum.* There are often found fifh, infects, and vegetables included in it, which teftify its once having been liquid. It is more tranfparent than moft part of the other bitumens, and is doubtlefs that fubftance which firft gave rife to electrical experiments.

Its varieties are reckoned from the colour and tranfparency: it is found,

A. Opake.

a. Brown. *b.* White. *c.* Blackifh.

B. Tranfparent.

a. Colourlefs.

b. Yellow. The greateft quantity of European amber is found in Pruffia; but it is, befides, collected on the fea-coaft of the province of Skone, and at Biorko, in the Lake Malaren, in the province of Upland; as alfo in France and in Siberia. It is chiefly employed in medicines, and for making varnifhes.

191 III. Rock-oil; *Petroleum.* It is an inflammable mineral, of a light-brown colour, which cannot be decompounded, but is often rendered impure by heterogeneous admixtures. In length of time, it hardens in the open air, like a vegetable refin; and then becomes of a black colour, whether it is pure, or mixed with other bodies. It is likewife found in the earth.

A. Liquid.

1. Naphtha. This is faid to be of a very fragrant fmell, tranfparent, extremely inflammable, and attracts gold. It is gathered from the furface of the water in fome wells in Perfia.

INFLAMMABLES. Rock-oil. Sulphur.

2. Rock-oil; *Petroleum*, properly fo called. This fmells like the oil of amber, though more agreeable, and is likewife very ready to take fire. It is collected in the fame manner as the naphtha, from fome wells in Italy, 192
and in a deferted mine at Ofmundfberget in the province of Dalarne in Sweden: at this laft-mentioned place it is found in fmall hollows in the limeftone, as refin is in the wood of the pines.

B. Thick and pitchy rock-oil, or Barbadoes tar; 193
Petroleum tenax, maltha. Refembles foft pitch.

C. Hardened rock-oil; *Petroleum induratum.* 194
Foffil pitch; *Pix montana.*

1. Pure; *Afphaltum.* This leaves no afh or earthy fubftance when it is is burnt. From this or the preceding fubftance, it is probable the afphaltum was prepared that the Egyptians ufed in embalming their dead bodies, and which is now called *mummia.*

2. Impure; *Pix montana impura.* This contains a great quantity of earthy matter, which is left in the retort after diftillation, or upon the piece of charcoal if burnt in an open fire; it coheres like a flag, and is of the colour of black lead: but in a calcining heat this earth quickly volatilifes; fo that the nature of it is not yet known. The fubftance which rifes, and then falls into the receiver during the diftillation of this foffil pitch, is entirely the fame as the common natural liquid rock-oil.

IV. Mineral phlogifton, or bitumen, united with 195
the vitriolic acid. Sulphur, or brimftone. This is very common in the earth, and difcovers itfelf in many and various forms. It is found,

A. Native fulphur. In this the two conftituent parts are mixed in due proportion in regard to each other, according to the rules of that attraction which is between them; it is eafily known,

1. By its inflammability, and by its flame.

2. By its fmell when burnt; and,

3. By its producing a liver of fulphur, when mixed with a fixed alkali, like that made from artificial fulphur.

It is found,

a. Pellucid, of a deep yellow colour.

b. Opake, white, and greyifh. It is often found on limeftone, which the vitriolic acid has left untouched, having a ftronger attraction to the phlogifton, and therefore wholly uniting with that.

B. Sulphur that has diffolved or is faturated with 196
metals.

1. With iron. Pyrites, or copperas-ftone; *Pyrites.* This is the fubftance from which moft fulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic fhining colour.

A. Pale yellow pyrites; *Pyrites fubflavus.* Marcafite. This is very common, and contains a proportionable quantity of fulphur with refpect to the iron; when once thoroughly inflamed, it burns by itfelf.

 a. Of

a. Of a compact texture; *Polita piedra del ynca, Hifpanorum.*
b. Steel-grained.
c. Coarfe-grained.
d. Cryftallifed. It fhoots moftly into cubical and octoëdral figures, tho' it alfo cryftallifes into innumerable other forms.

197 B. Liver-coloured marcafite. Its colour cannot be defcribed, being betwixt that of the preceding marcafite, and the azure copper ore. The iron prevails in this kind; it is therefore lefs fit to have fulphur extracted from it, and alfo for the fmelting of copper ores. It is found,
a. Of a compact texture.
b. Steel-grained.
c. Coarfe-grained.

198 2. Iron and tin. Black-lead, or wadd; *Molybdæna.* If by fuch a mixture as this the iron and tin be not rendered too volatile, it muft be fuppofed that the great lofs the black lead fuftains in the calcining heat is occafioned from the fulphur, and that the fulphur confequently makes out the greateft part of the black lead. It is found,
a. Lamellar and fhining, of the fame colour as the potters lead ore.
b. Of a fteel-grained and dull texture. It is naturally black, but when rubbed it gives a dark lead colour.
c. Of a fine fcaly and coarfe-grained texture; coarfe black lead. It has at the fame time a fcaly and a granulated appearance. From Gran in the province of Upland, and from Tavaftehuflan in Finland. Profeffor Pott has examined the black lead in covered veffels, and Mr Quift in an open fire; from which difference in the method of treating it, different notions have arifen: becaufe the black lead is nearly unalterable when expofed to the fire in covered veffels, or when immediately put into a ftrong charcoal fire, but it is almoft wholly volatile in a calcining heat. This is the cafe with feveral others of the mineral phlogiftons; and from this we may in general learn, how neceffary it is to examine the mineral bodies by many and different methods, and to endeavour to multiply the experiments more than what has been hitherto done.

199 3. Sulphur with iron and copper; yellow or marcafitical copper ore.
4. Sulphur with iron and lead; potters lead-ore.
5. Sulphur with iron and zinc; mock lead, black jack, or blende.
6. Sulphur with iron and arfenic; arfenical pyrites.
7. Sulphur with iron and cobalt.
8. Sulphur with iron and bifmuth.
9. Sulphur with iron and nickel.
10. Sulphur with iron and gold; pyritical gold ore.
11. Sulphur with filver; glafs filver ore.
12. Sulphur with copper; grey or vitreous copper ore.

13. Sulphur with lead; potters lead ore.
14. Sulphur with bifmuth.
15. Sulphur with quickfilver; cinnabar.
16. Sulphur with arfenic, orpiment, *realgar.*

V. Mineral phlogifton united with earths. 200
A. With a calcareous earth.
1. With pure calcareous earth; the fetid or fwine fpar.
2. With the calcareous earth and vitriolic acid; the *leberftein* or *liverftone* of the Swedes.

B. With an argillaceous earth.
1. With a fmall quantity of argillaceous earth and vitriolic acid: Coal; *Lithantrax.* It is of a black colour, and of a fhining texture; it burns, and is moftly confumed, in the fire; but leaves, however, a fmall quantity of afhes.
a. Solid coal. b. Slatty coal.
2. With a greater quantity of argillaceous earth and vitriolic acid; the *kolm* of the Swedes. This is of the fame appearance with the former, though of a more dull texture; it burns with a flame, and yet is not confumed, but leaves behind a flag of the fame bulk or volume as the coal was.
3. With abundance of argillaceous earth; ftone coal. It burns with a flame by itfelf, otherwife it looks like other flates.

VI. Mineral phlogifton mixed with metallic earths. 201

This is not found in any great quantity: in regard to its external appearance, it refembles pit-coal; and the fat fubftance contained in it, at times, partly burns to coal, and partly volatilifes in a calcining heat.

The only known varieties of this kind are,

A. Minera cupri phlogiftica.

When it has been inflamed, it retains the fire, and at laft burns to afhes, out of which pure copper can be fmelted.

B. Minera ferri phlogiftica.

This is not very different in its appearance from the pit-coal or foffil pitch, but it is fomewhat harder to the touch. There are two varieties of this fpecies:

1. Fixt in the fire; *Minera ferri phlogiftica fixa.*
Expofed to a calcining heat, it burns with a very languid though quick flame; it preferves its bulk, and lofes only a little of its weight. It yields above 30 per cent. of iron.
a. Solid, refembles black fealing-wax.—— It is found in the liver-coloured marcafite in Wafkberget, at Norrberke in Weftmanland.
b. Cracked, and friable.
2. Volatile in the fire.
This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe; but under a muffle the greateft part of it volatilifes, fo that only a fmall quantity of calx of iron remains. It is found,
a. Solid.
b. Cracked.

This laft kind leaves more afhes: thefe afhes,

aſhes, when farther expoſed to the fire, become firſt yellowiſh-green, and afterwards reddiſh-brown, when, beſides iron, they then alſo diſcover ſome marks of copper; it has, however, not been poſſible to extract any metallic ſubſtance from them, the effects of the loadſtone, and the colour communicated to the glaſs of borax, having only given occaſion to this ſuſpicion.

FOURTH CLASS.

METALS.

202 Are thoſe mineral bodies which, with reſpect to their volume, are the heavieſt of all hitherto-known bodies; they are not only malleable, but they may alſo be decompounded, and in a melting heat be brought again to their former ſtate, by the addition of the phlogiſton they had loſt in their decompoſition.

Thoſe metals which in a calcining heat loſe their phlogiſton, and conſequently with that the former coherency of their particles, are called *imperfect;* as tin, lead, copper, and iron, and all the ſemi-metals (of which more hereafter): notwithſtanding which, they may be malleable. But thoſe which cannot be deſtroyed in the fire alone are called *perfect;* as gold, ſilver, and platina del pinto. Neverthelefs, the metals have commonly been conſidered more with regard to their malleability than to their fixity in the fire; and are therefore divided into,

A. Malleable, which are called *metals;* and,

B. Brittle, which are called *ſemi-metals.*

The zinc is, however, as a medium between theſe two diviſions, juſt as the quickſilver is between the perfect and imperfect metals; becauſe the quickſilver may indeed be ſo far deſtroyed in the fire, that its particles are ſeparated during their volatiliſation; but every one of them, even the minuteſt, retains, however, the phlogiſton united with it.

The First Order. *True Metals.*

203 I. Gold; *Aurum, ſol chymicorum.*

This is by mankind eſteemed as the principal and firſt among the metals; and that partly for its ſcarcity, but chiefly for the following qualities:

1. It is of a yellow ſhining colour.
2. It is the heavieſt of all known bodies, its ſpecific gravity to water being as 19,640 to 1000.
3. It is the moſt tough and ductile of all metals; becauſe one grain of it may be ſtretched out ſo as to cover a ſilverwire of the length of 98 yards, by which means $\frac{1}{105000}$ grain becomes viſible to the naked eye.
4. Its ſoftneſs comes neareſt to that of lead, and conſequently it is but very little elaſtic.
5. It is fixed and unalterable in air, water, and fire, becauſe it does not eaſily quit its phlogiſton; its liquid menſtruum being only made by art.

It has, however, according to Homberg's experiments, when expoſed to Tſchirnhauſen's burning-glaſs, been found partly to volatiliſe in form of ſmoke, and partly to ſcorify: but this wants to be farther examined. It is alſo ſaid, that gold, in certain circumſtances, and by means of certain artifices in electrical experiments, may be forced into glaſs; and that on this occaſion it becomes white, leaving a black duſt behind it; which, if ſo, confirms certain other chemical experiments, viz. That gold can, together with its colour, loſe ſomething of its phlogiſton, and yet retain its heavineſs, ductility, &c.

6. When melted, it reflects a bluiſh-green colour from its ſurface.
7. It diſſolves in aqua regia, which is compoſed of the acids of ſea-ſalt and nitre; but not in either alone, nor in any other ſolution of ſalt or acid whatſoever.
8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua regia, it burns off quickly, in the leaſt degree of heat, with a ſtrong fulmination.
9. It is diſſolved, *in forma ſicca*, by the liver of ſulphur, and alſo ſomewhat by the glaſs of biſmuth.
10. It is not carried away by the antimony during the volatiliſation of that ſemi-metal, and is therefore conveniently ſeparated from other metals by the help of crude antimony; in which proceſs the other metals are partly made volatile, and fly off with the antimony, and partly unite with the ſulphur, to which the gold has no attraction, unleſs by means of ſome uniting body, or by a long digeſtion.
11. The phoſphorus is ſaid to have ingreſs into gold.
12. If mixed with a leſs portion of ſilver, platina, copper, iron, and zinc, it preſerves tolerably well its ductility. But,
13. When mixed with tin, it becomes very brittle; and it attracts likewiſe the ſmoke of that metal ſo as to be ſpoiled, if melted in an hearth where tin has been lately melted: And this is perhaps the reaſon why gold becomes brittle, and of a paler colour, when melted in a new black lead crucible.
14. It requires a ſtrong heat before it melts, nearly as much, or a little more than copper.
15. It mixes or amalgamates readily with quickſilver.

A. Native gold is in its metallic form commonly pure: and in this ſtate moſt part of this metal 204
uſed in the world is found. With reſpect to either the figure or the quantity in which it is found in one place, it is by miners divided into,

1. Thin ſuperficial plated or leaved gold; which conſiſts of very thin plates or leaves, like paper.
2. Solid or maſſive, is found in form of thick pieces.
3. Cryſtalliſed, conſiſts of an angular or cryſtalline figure.
4. Waſh gold, or gold duſt, is waſhed out of ſands, wherein it lies in form of looſe grains

and lumps. The gold is in general more frequently imbedded and mixed with quartz than with any other kind of ftone; and the quartz in which the gold is found in the Hungarian gold mines is of a peculiar appearance. All other forts of ftones, however, are not to be excluded, fince gold is likewife found in fome of them; for inftance, in limeftone, in Adolph Fredrik's Grufva at Adelfors in the province of Smoland in Sweden; in Hornblende, in Baftnas Grufva at Riddarfhyttan in the province of Weftmanland; not to mention feveral other gold mines.

205 *B.* Mineralifed gold. This is an ore in which the gold is fo far mineralifed, or fo entangled in other bodies, as not to be diffolved by the aqua regia.

1. Mineralifed with fulphur.
   - *a.* Mineralifed by means of iron. Marcafitical gold ore; *Pyrites aureus.* It is found at Adelfors, in the province of Smoland; and contains an ounce of gold, or lefs, in 100 pounds.
   - *b.* Mineralifed by means of quickfilver. It is found in Hungary.
   - *c.* Mineralifed by means of zinc and iron; *Aurum fulphure mineralifatum mediante zinco & ferro, aut argento.* The Schemnitz blende. At Schemnitz in Hungary are found zinc ores, which contain a great deal of filver, and this filver is very rich in gold. Since gold and fulphur have no immifcible power or attraction to one another, many have infifted that gold never could be found in marcafite, or thofe ores which contain fulphur: but fince we know by experience that gold can be melted out of the above-mentioned ores, although they have been previoufly digefted in aqua-regia; and that gold likewife mixes and diffolves into a regulus; there is the greateft reafon to believe that a third fubftance, which here is a metal, muft neceffarily have by its admixture enabled the fulphur to unite with a certain quantity of gold. Scheffer has given upon this fubject fome very curious and ufeful obfervations, in his Hiftory of the Refining of Metals, inferted in the Tranfactions of the Academy of Sciences at Stockholm.

It is, however, by no means hereby intended to confirm the credulous in their opinion, that the marcafites in general contain more gold than what true metallurgifts have afferted; becaufe fraud might then perhaps become too common. It is only meant to indicate, that, as no gold is to be expected from marcafites, where no native gold is found in the neighbourhood, in the fame manner no marcafites ought to be defpifed which are found in tracks where gold ores are dug: but at the fame time care muft be taken not to be deluded by the mention of volatile gold, as it is a notion really contradictory and fufpicious; and then there can be no fear of being mifled.

II. Silver; *Argentum, luna.* Which is, 206

- *a.* Of a white fhining colour.
- *b.* Its fpecific gravity to water is 11,091 to 1000.
- *c.* It is very tough or ductile, fo that a grain of it may be ftretched out to three yards in length, and two inches in breadth.
- *d.* It is unalterable in air, water, and fire.
- *e.* It diffolves in the acid of nitre, and alfo by boiling in the acid of vitriol.
- *f.* If precipitated out of the acid of nitre with the common falt, or with its acid, it unites fo ftrongly with this laft acid, that it does not part from it, even in the fire itfelf, but melts with it into a mafs like glafs, which is called *luna cornea.*
- *g.* It does not unite with the femi-metal nickel, during the fufion.
- *h.* It amalgamates eafily with quickfilver.
- *i.* It is in the dry way diffolved by the nitre of fulphur.
- *k.* It has a ftrong attraction to fulphur, fo as readily to take a reddifh yellow or black colour, when it is expofed to fulphureous vapours.
- *l.* It has no attraction to arfenic; whence, when the red arfenical filver ore, or *rothgulden ertz* of the Germans, is put into the fire, the arfenic flies off, and leaves the fulphur (which in this compound was the *medium uniens*) behind, united with the filver in form of the glafs filver ore, or glafs ertz.
- *m.* It is not diffolved by the glafs of lead, and confequently it remains on the cupel.
- *n.* It is exhaled or carried off by volatile metals and acids, as by the vapours of antimony, zinc, and the acid of common falt.
- *o.* It melts eafier than copper.

Silver is found,

A. Native or pure. 207

Native filver moft generally is nearly of fixteen carats ftandard.

1. Thin fuperficial plated or leaved filver.
2. It is alfo found in form,
   - *a.* Of fnaggs, and coarfe fibres.
   - *b.* Of fine fibres. Capillary filver.
   - *c.* Arborefcent. From Potofi in America, and Kongfberg in Norway.
   - *d.* Cryftalline, or figured. This is very fcarce to be met with: it has diftinct figures, with fhining furfaces; it is, however, fometimes found at Kongfberg.

The filver from America is faid to be found for the moft part native; fo it is likewife at Kongfberg in Norway; but it is not commonly fo in the other European mines. In Sweden, it is found native in a very fmall quantity, in the mines of Salberg in Weftmanland, of Lofafen in Dalarne, of Hevaffwik and Sladkierr in the province of Dal, of Sunnerfkog in the province of Smoland, and in the ifland Utoen in the Lake Malaren. It was once found in pretty large lumps in a vein

vein of clay in one of the iron mines at Normark, in the province of Wermeland. It was there mixed with nickel, which was partly decayed or withered; and under this circumſtance it formed the compound ore called the *ſtercus anſerinum*, or *gooſe-dung ore*. At this place the argillaceous vein croſſes the veins of the iron ore, and will perhaps be found to have more of theſe riches, even in ſeveral other places, if well ſearched, as is done in other countries, oftentimes not on ſuch evident marks or ſigns.

208 *B.* Diſſolved and mineraliſed.

(1.) With ſulphur alone. Glaſs ſilver ore,

This is ductile, and of the ſame colour as lead; but, however, becomes blacker in the air. It has, therefore, very undeſervedly got the name of *glaſs-ore;* for that name rather belongs to the *minera argenti cornea*, or horn ſilver ore, if indeed any ſilver ore can be conſidered as glaſſy.

It is found in the ſame manner as native gold; *viz.*

1. In cruſts, plates, or leaves.
2. Grown into
   a. Snaggs, and
   b. Chryſtalline figures.

It is generally either of a lamellar or a grained texture, and is found at Kongſberg and in the Saxon mines.

The glaſs ſilver ore is the richeſt of all ſilver ores; ſince the ſulphur, which is united with the ſilver in this ore, makes out but a very ſmall quantity of its weight.

209 (2.) With ſulphur and arſenic. The red or ruby-like ſilver ore. The *rothgulden* of the Germans.

The colour of this ore varies as the proportion of each of theſe ingredients varies in the mixture; viz. from dark grey to deep red: but when it is rubbed or pounded, it always gives a red colour. When put in the fire, it crackles and breaks; and when the crackling ceaſes, it melts eaſily, the arſenic at the ſame time exhaling in ſmoke.

a. Grey arſenical ſilver ore: which is either,
   1. Plated, cruſted, or leaved; and,
   2. Solid.

b. The red arſenical ſilver ore:
   1. Plated, cruſted, or leaved;
   2. Solid or ſcaly; and,
   3. Cryſtalliſed.

In this laſt form it ſhows the moſt beautiful red colour, and is often ſemitranſparent. It contains about 60 *per cent.* in ſilver; and is found in the greateſt quantity at Andreaſberg in the Hartz.

210 (3.) With ſulphurated arſenic and copper. The *weiſſgulden* of the Germans.

This, in its ſolid form, is of a light grey colour, and of a dull and ſteel-grained texture. The more copper it contains, the darker is the colour. It often holds ſeven pounds of ſilver *per cent.* It is,

a. Friable, withered, or decayed, of a black or ſooty colour; and is therefore by the Germans called *ſilber-ſchwartz*, or *Ruſſigtes-ertz.*

b. Solid, of a light grey colour, and is that ſort properly called *weiſſgulden.*

It is found at St Mary of the Mines in Alſatia, the Saxon mines, and at St Andreaſberg in the Hartz.

(4.) With ſulphurated arſenic and iron. The *weiſertz*, or white ſilver ore, of the Germans. 211

This is an arſenical pyrites, which contains ſiver; it occurs in the Saxon mines, and ſo exactly reſembles the common arſenical pyrites as not to be diſtinguiſhed from it by ſight alone, or without other means. The ſilver it contains may perhaps conſiſt of very ſubtile capillary ſilver mixed in it.

(5.) With ſulphurated antimony. 212

a. Of a dark-grey and ſomewhat browniſh colour. The *lebererz*, from Braunſdorff in Saxony.

b. Of a blackiſh blue colour.
   1. In form of capillary cryſtals. *Federertz*, or plumoſe ſilver ore.

It is found in Saxony, and contains only two or four ounces of ſilver *per cent.* 213

(6.) With ſulphurated copper and antimony. The Dal *falertz.*

This reſembles, both in colour and texture, the dark-coloured weiſſgulden, or falertz. When rubbed, it gives a red powder.

a. Solid.

b. Cryſtalliſed, is found in the pariſh of Aminſkog in the province of Dal; and at that place has been for ſeveral years melted by a method invented for the different mixture of the ores; which proceſs muſt be very troubleſome to thoſe who are not perfectly well verſed in metallurgy.

It contains 13 ounces of ſilver, and 24 *per cent.* of copper.

(7.) With ſulphurated zinc. The *pechblende* of the Germans. 214

This is a zinc ore, mock lead, or blende, which contains ſilver, and is found among rich ſilver and gold ores; for inſtance, in the Hungarian and Saxon mines.

a. Of a metallic changeable colour.
   1. Solid, and with fine ſcales.
   2. In form of balls. The *kugel-ertz*, or ball ore.

It is found at Schemnitz, and contains alſo gold. Its yield of ſilver is 24 ounces *per cent.* and 30 *per cent.* of zinc.

b. Black mock lead, or blende, found in Saxony. This is alſo found,
   1. Solid, and with fine ſcales;
   2. And in form of balls.

(8.) With ſulphurated lead; potters ore. *Galena, bleyglanz.* 215

(9.) With

True METALS. *Platina.*

(9.) With fulphurated lead and antimony, called *ftriperz.*

216 (10.) With fulphurated iron. *Silberhaltiger kies;* marcafite holding filver.

At Kongfberg in Norway, it is faid, a liver-coloured marcafite is often found, particularly at the mine called *Fraulein Chriftiana,* &c. This marcafite contains of filver from three ounces to three and an half *per cent.*

217 (11.) With the acid of common falt. *Minera argenti cornea. Hornertz,* or horn-filver ore.

This is the fcarceft filver ore; it is of a white or pearl colour, changeable or varying on the furface, femi-tranfparent, and fomewhat ductile both when crude and when melted. It cannot be decompofed without fome admixture of fuch fubftances as attract the acid of the fea-falt. It is found in very thin wrought leaves or crufts, at Johan Georgenftadt, in Saxony.

218 III. Platina del Pinto; *Juan blanca.*

This metal is a recent difcovery of our times; and is defcribed with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm for the year 1752; as alfo by Dr Lewis, in the Philofophical Tranfactions for the year 1754, vol. xlviii. And though thefe two gentlemen agree in the principal circumftances relating to this metal, yet it is very plain by their defcriptions, that neither of them knew any thing of the other's experiments. By thefe defcriptions we are convinced of the refemblance this metal bears to gold; and therefore we muft allow it to be called *white gold,* though, both theoretically and practically, it may be diftinguifhed from gold by the following qualities.

1. It is of a white colour.
2. It is fo refractory in the fire, that there is no degree of heat yet found by which it can be brought into fufion by itfelf, the burning-glafs excepted, which has not yet been tried. But, when mixed with other metals and femi-metals, it melts very eafily, and efpecially with arfenic, both in its metallic form and in form of a calx or glafs.
3. It does not amalgamate with quickfilver by itfelf, but only by means of the acid of common falt after a long trituration. This metal is therefore really feparated from gold by amalgamation, at thofe places where it is found; and without this quality it would be very difficult to feparate it.
4. It is harder and lefs coherent than gold.
5. It is heavier than gold; and therefore the heavieft of all bodies hitherto difcovered: for though the fpecific gravity of platina, in the hydroftatical experiments made by Dr Lewis, is found to be to water only as 17,000 to 1000; yet, when melted with other certain metals, its fpecific gravity has, by an exact calculation, been found to be confiderably augmented, even fo much as to 22,000.
6. Diffolved in aqua regia, and precipitated with tin, or with a folution of that metal, it yields no *purpura mineralis.*

True METALS. *Tin.*

Except thefe, this metal has the fame qualities as gold: but it cannot, on account of its refractorinefs in the fire, be worked off pure on the cupel, nor can it be worked with antimony; becaufe, before it is rendered perfectly pure, it cools, grows hard, and retains always fome part of the added metals. It is brought to us only in its native ftate, in fmall, irregular, rugged grains; and it is yet uncertain whether it is found naturally mineralifed. The platina is brought to Europe from the Rio del Pinto, in the Spanifh Weft Indies.

IV. Tin; *Stannum, Jupiter.* 219

This is diftinguifhed from the other metals by the following characters and qualities.

a. A white colour, which verges more to the blue than that of filver.
b. It is the moft fufible of all metals; and,
c. The leaft ductile; that is, it cannot be extended or hammered out fo much as the others.
d. In breaking or bending it makes a crackling noife.
e. It has a fmell particular to itfelf, and which cannot be defcribed.
f. In the fire it is eafily calcined to white afhes, which are 25 *per cent.* heavier than the metal itfelf. During this operation, the phlogifton is feen to burn off in form of fmall fparkles among the afhes, or calx.
g. This calx is very refractory; but may, however, with a very ftrong degree of heat be brought to a glafs of the hard refin. But this calx is eafily mixed in glafs compofitions, and makes with them the white enamel.
h. It unites with all metals and femi-metals; but renders moft of them very brittle, except lead, bifmuth, and zinc.
i. It amalgamates eafily with quickfilver.
k. It diffolves in aqua-regia, the fpirit of fea-falt, and the vitriolic acid; but it is only corroded into a white powder by the fpirit of nitre.

The vegetable acid, foaps, and pure alkaline falts, alfo corrode this metal by degrees.

l. Its fpecific gravity to water is as 7400 to 1000, or as 7321 to 1000.
m. Diffolved in aqua-regia, which for this purpofe ought to confift of equal parts of the fpirit of nitre and fea-falt, it heightens the colour of the cochineal, and makes it deeper; for otherwife that dye would be violet.

Tin is not found naturally in the earth in any other ftate than, 220

(1.) In form of a calx.

A. Indurated, or vitrified.

1. Mixed with a little of the calx of arfenic.

A. Solid tin ore, without any determinate figure; tin-ftone.

It refembles a garnet of a blackifh-brown colour, but is a great deal heavier; and has been confidered, at the Englifh tin-mines, as a ftone containing no metal, until fome years ago it began to be fmelted to great advantage.

B. Cryftallifed; tin-grains.

Is like the garnets, of a fpherical polygonal

True METALS. Lead.

polygonal figure, but looks more unctuous on the surface.

1. In larger grains; and,
2. In smaller grains.

2. Mixed with the calx of iron.
3. Mixed with the manganese.
4. Mineralised with sulphur and iron; black lead.

221 V. Lead; *Plumbum*, *Saturnus*. It is,

a. Of a blueish-white colour when fresh broke, but soon dulls or sullies in the air.

b. Is very heavy; viz. to water as 11,325 to 1000.

c. Is softest next to gold; but has no great tenacity, and is not in the least sonorous.

d. It is easily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.

e. This calx melts easier than any other metallic calx to a glass, which becomes of a yellow colour, and semi-transparent. This glass brings other bodies, and the imperfect metals, into fusion with it.

f. It dissolves, 1st, In the spirit of nitre; 2dly, In a diluted oil of vitriol, by way of digestion; 3dly, In the vegetable acid; 4thly, In alkaline solutions; and 5thly, In expressed oils, both in the form of metal and of calx.

g It gives a sweet taste to all solutions.

h. It amalgamates with quicksilver.

i. With the spirit of sea-salt it has the same effect as silver, whereby is produced a *saturnus corneus*.

k. It does not unite with iron, when it is alone added to it in the fire.

l. It works on the cupel, which signifies that its glass enters into certain porous bodies, destitute of phlogiston and alkaline salts.

m. It melts in the fire before it is made red-hot, almost as easily as the tin.

n. Its calx or glass may be reduced to its metallic state by pot-ashes.

222 Lead is found,

A. In form of a calx.

(1.) Pure.

A. Friable; lead ochre; native cerufs. This is found at Kristiersberget in Westmanland in Sweden, on the surface of the potter's ore.

B. Indurated; lead spar, or spatose lead ore.

1. Radiated, or fibrous.
   a. White.
2. Crystallised into a prismatical figure.
   a. White.
   b. Yellowish green.

223 (2.) Mixed.

A. With the calx of arsenic; arsenic lead-spar.

1. Indurated.

a. White. Mr Cronstedt has tried such an ore from an unknown place in Germany, and found that no metallic lead could be melted from it by means of the blow-pipe, as can be done out of other lead spars; but it must be performed in a crucible, and then that part of the arsenic which did not fly off in smoke during the experiment was likewise reduced, and found in form of grains dispersed, and forced into the lead. Another ore of this kind, which likewise was not easily reduced by means of the blow-pipe, did always, after being melted, and during the cooling, hastily shoot into polygonal, but mostly hexagonal, crystals, with shining surfaces. Can this crystallisation be owing to salts, which are said not to act in this manner but when they are dissolved in water?

B. With a calcareous earth.

The above-mentioned lead ores are very rich in lead, and easy to be tried; because most of them, being slowly heated, may be reduced to lead by means of the blow-pipe on a piece of charcoal. The calx of the lead in these ores has, perhaps, first been dissolved by sulphur and arsenic; and has afterwards, when these two have weathered away or decayed, and parted from it, assumed this form, in the same manner as we see it really happens, during the calcination, with rich lead ores, or such regules as contain lead. The same, very likely, is the case with other metals; for which reason their ores, when they occur in form of a calx, often contain a little sulphur, and more especially arsenic.

B. Mineralised.

1. With sulphur alone: the *bley-schweiff*, or *bleyglanz*, of the Germans. 224

a. Steel-grained lead-ore; from the mines at Hellefors, in the province of Westmanland.

b. Radiated, or antimoniated lead-ore.

c. Tessellated, or potter's lead-ore.

At Villach in Austria there is said to be found a potter's lead-ore, which contains not the least portion of silver.

2. With sulphurated silver. *Galena*; also called *bleyglanz*, by the Germans. 225

a. Steel-grained.

b. With small scales; is found at Selberg, and is there particularly called *blyschweif*.

c. Fine-grained.

d. Of a fine cubical texture; and,

e. Of coarse cubes. These two varieties are found in all the Swedish silver-mines.

f. Crystallised.

The steel-grained and scaly ores are of a dim and dull appearance when they are broke, and their particles have no determined angular figure: they are therefore in Swedish commonly called *blyschweif*; in opposition to the cubical ores, which are called *blyglanz*. The most part of the ores called *blyglanz* contain silver, even to 24 ounces *per cent*. of which we have instances in the mines of Salberg, where it has been observed, that the coarse cubical lead ores are generally the richest in silver, contrary to what

True METALS. Copper.

what is commonly taught in books; the reafon of which may perhaps be, that, in making the effays on thefe two ores, the coarfe cubical can be chofen purer or freer from the rock than the fine cubical ores.

226 3. With fulphurated iron and filver. This is found,

a. Fine-grained. *b.* Fine cubical. *c.* Coarfe cubical. When this ore is fcorified, it yields a black flag; whereas the preceding lead-ores yield a yellow one, becaufe they do not contain any iron.

227 4. With fulphurated antimony and filver; antimoniated or radiated lead-ore. This has the colour of a blyglanz, but is of a radiated texture.

It is found,

a. Of fine rays and fibres; and,

b. Of coarfe rays or fibres. The lead in this ore prevents any ufe being made of the antimony to advantage; and the antimony likewife in a great meafure hinders the extracting of the filver.

228 VI. Copper; *Cuprum, Venus, Æs.*

This metal is,

a. Of a red colour.

b. The fpecific gravity of the Japan copper is 9000, and of the Swedifh 8784 or 8843 to 1000.

c. It is pretty foft and tough.

d. The calx of copper being diffolved by acids becomes green, and by alkalies blue.

e. It is eafily calcined in the fire into a blackifh blue fubftance, which, when rubbed to a fine powder, is red; when melted together with glafs, it tinges it firft reddifh brown, and afterwards of a tranfparent green or fea-green colour.

f. It diffolves in all the acids; viz. the acids of vitriol, fea-falt, nitre, and the vegetable; and likewife in all alkaline folutions. That it becomes rufty, and tarnifhes in the air (a confequence of a former folution), depends very much on fome vitriolic acid which is left in the copper in the refining of it. This metal is eafier diffolved when in form of a calx than in a metallic ftate, efpecially by the acids of vitriol and fea-falt, and the vegetable acid.

g. Vitriol of copper is of a deep blue colour; but the vegetable acid produces with the copper a green falt, which is verdigrife.

h. It can be precipitated out of the folutions in a metallic ftate; and this is the origin of the precipitated copper of the mines, called *Ziment copper.*

i. It is not eafily amalgamated with quickfilver; but requires for this purpofe a very ftrong trituration, or the admixture of the acid of nitre.

k. It becomes yellow when mixed with zinc, which has a ftrong attraction to it, and makes brafs, pinchbeck, &c.

l. It is eafily diffolved by lead glafs, which laft is coloured green by it.

m. When this metal is expofed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do fo afterwards, without lofing any thing confiderable of its weight.

n. It requires a ftrong degree of heat before it melts, yet is it a leffer degree than for iron.

Copper is found in the earth, 229

A. Native, or in a metallic ftate; virgin or native copper.

1. Solid, is found in the iron mine of Hefslekulla in the province of Nerike, and at Sunnerfkog in the province of Smoland; alfo in the Ruffian Carelia, and in other foreign places.

2. Friable, in form of fmall, and fomewhat coherent grains. Precipitated or ziment copper. It is found at Riddarfhyttan in Weftmanland, at Fahlun in Dalarne, and in Hungary.

It has been obferved, that both copper and filver glafs ore, being precipitated from water, become friable and granulated, but that they in time grow folid and ductile: whence the difpute about the diftinction between native and precipitated copper may ceafe; the rather as native copper will fcarcely be found in other places, and in any other kinds of ftones, than thofe thro' which the ziment or vitriolic waters have circulated; although the fiffures through which it has run may afterwards be filled with a ftony fubftance.

B. In form of a calx. 230

(1.) Pure.

A. Loofe or friable; *Ochra veneris.*

1. Blue; *Cæruleum montanum.* Is very feldom found perfectly free from a calcareous fubftance.

2. Green; *Viride montanum.* Both thefe colours depend on menftrua, which often are edulcorated or wafhed away.

3. Red. This is an efflorefcence of the glafs copper ore. It is found in the province of Dal, and at Oftanberg in the province of Dalarne.

B. Indurated. Glafs copper ore. 231

a. Red. This is fometimes as red as fealing wax, and fometimes of a more liver-brown colour. It is found in Sandbacken, at Norberg in Weftmanland, at Ordal in Norway, in Siberia, and in Suabia in Germany.

This ore is always found along with native copper, and feems to have loft its phlogifton by way of efflorefcence, and to be changed into this form. It is likewife found along with the fulphurated copper; and is commonly, though very improperly, called *glafs copper ore.*

(2.) Mixed. 232

A. Loofe or friable; *Ochra veneris friabilis impura.*

1. Mixed with a calcareous fubftance; *Cæruleum montanum.* In this ftate copper blue is moftly found. It ferments during the folution in aquafortis.

2. Mixed with iron. Black. It is the decom-

decompofition of the Fahlun copper ore.

B. Indurated.

1. Mixed with gypfum, or plafter. Green. Is found at Ordal in Norway, and there called *malachites*.

2. Mixed with quartz. Red. From Sunnerfkog in the province of Smoland.

3. Mixed with lime. Blue. This is the *lapis armenus*, according to the accounts given of it by authors.

C. Diffolved and mineralifed; *Cuprum mineralifatum*.

233 (1.) With fulphur alone. Grey copper ore. Is improperly alfo called *glafs copper ore*.

a. Solid, without any certain texture. This is very foft, fo that it can be cut with a knife, almoft as eafily as black lead.

b. Fine-cubical; *Minera cupri fulphurata teffilis conftans minoribus*. Both thefe varieties are found at Sunnerfkog in Smoland; where the laft is fometimes found decompofed or weathered, and changed into a deep mountain blue.

234 (2.) With fulphurated iron. *Minera cupri pyritacea*; yellow copper ore. Marcafitical copper ore; *Pyrites cupri*. This is various both in regard to colour, and in regard to the different proportion of each of the contained metals; for inftance,

a. Blackifh grey, inclining a little to yellow; *Pyrites cupri grifeus*. When decayed or weathered, it is of a black colour; is the richeft of all the varieties of this kind of copper ore, yielding between 50 and 60 *per cent.* and is found in Spain and Germany.

b. Reddifh yellow, or liver brown, with a blue coat on the furface; *Minera cupri lazurea*. This ore yields between 40 and 50 *per cent.* of copper, and is commonly faid to be blue, though it is as red, when frefh broke, as a red copper regulus.

c. Yellowifh green; *Pyrites cupri flavo viridefcens*. This is the moft common in the north part of Europe; and is, in regard to its texture, found,

1. Solid, and of a fhining texture, from Oftanberg in the province of Dalarne.

2. Steel-grained, of a dim texture, from the fame place, and Falun in Dalarne.

3. Coarfe-grained, is of an uneven and fhining texture. It occurs in moft of the Swedifh and Norwegian copper mines.

4. Cryftallifed marcafitical copper ore.

a. Of long octoëdrical cryftals. This is found at Hevaffwik in the province of Dal, and in Lovifagrufva in Weftmanland; notwithftanding its exiftence is denied by Henckel and his followers.

d. Pale-yellow. This cannot be defcribed but as a marcafite, though an experienced eye will eafily difcover fome difference between them. It yields 22 *per cent.* of copper.

e. Liver-coloured. This is found at Falun, in Darlarne in Sweden, where it contains copper; though at moft other places where it occurs, it does not contain any copper, but is only a martial marcafite.

(3.) With fulphurated arfenic and iron. White copper ore. It is faid to be found in the Hartz in Germany, and to refemble an arfenical pyrites; but moft of the pyritical copper ores, as well as the marcafites, contain a little arfenic, though it is in too fmall a quantity to be obfervable. 235

(4.) Diffolved by the vitriolic acid; *Vitriolum veneris*. 236

(5.) With phlogifton. Copper coal-ore.

VII. Iron; *Ferrum, Mars*. It is, 237

a. Of a blackifh blue fhining colour.

b. It becomes ductile by repeated heating between coals, and hammering.

c. It is attracted by the loadftone, which is an iron ore; and the metal itfelf may alfo be rendered magnetical.

d. Its fpecific gravity to water is as 7,645, or 8000 : : 1000.

e. It calcines eafily to a black fcaly calx, which, when pounded, is of a deep red colour.

f. When this calx is melted in great quantity with glafs compofitions, it gives a blackifh brown colour to the glafs; but in a fmall quantity a greenifh colour, which at laft vanifhes, if forced by a ftrong degree of heat.

g. It is diffolved by all falts, by water, and likewife by their vapours. The calx of iron is diffolved by the fpirit of fea-falt, and by aqua regia.

h. The calx of the diffolved metal becomes yellow, or yellowifh brown; and in a certain degree of heat, it turns red.

i. The fame calx, when precipitated from acids by means of the fixed alkali, is of a greenifh colour; but it becomes blue, when precipitated by means of an alkali united with phlogifton; in which laft circumftance the phlogifton unites with the iron: thefe two precipitates lofe their colour in the fire, and turn brown.

k. The vitriol of iron is brown.

l. It is the moft common metal in nature, and at the fame time the moft ufeful in common life; notwithftanding which, its qualities are perhaps very little known.

Iron is found, 238

A. In form of calx.

[1.] Pure.

A. Loofe and friable. Martial ochre; *Minera ochracea*.

1. Powdery; *Ochra ferri*. This is commonly yellow or red, and is iron which has been diffolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More folid balls.

c. In fmall flat pieces, like cakes, or pieces of money.

d. In fmall grains.
e. In lumps of an indeterminate figure. All thefe are of a blackifh brown, or a light brown colour.

239 B. Indurated. The bloodftone; *Hæmatites.*

(1.) Of an iron colour; *Hæmatites cœrulefcens.* This is of a blueifh grey colour; it is not attracted by the loadftone, yields a red powder when rubbed, and is hard.
a. Solid, and of a dim appearance when broken.
b. Cubical, and of a fhining appearance when broken.
c. Fibrous, is the moft common *torrften* of Sweden.
d. Scaly; the *eifenman* of the Germans.
1. Black; from Gellebeck, in Norway.
2. Blueifh grey; from Reka Klitt. When this is found along with marcafite, as at Sandfwar in Norway, it is not only attracted by the loadftone, but is of itfelf really a loadftone.
e. Cryftallifed.
1. In octoëdrical cryftals.
2. In polyëdrical cryftals.
3. In a cellular form. Thefe varieties are the moft common in Sweden, and are very feldom blended with marcafite, or any other heterogeneous fubftance, except their different beds. It is remarkable, that, when thefe ores are found along with marcafite, thofe particles which have lain neareft to the marcafite are attracted by the loadftone, although they yield a red, or reddifh brown powder, like thofe which are not attracted by the loadftone: it is likewife worth obfervation, that they generally contain a little fulphur, if they are imbedded in a lime-ftone rock, which, however, very feldom happens in Sweden; but there is one fuch inftance at Billfia in Soderberke, in the province of Dalarne.

240 (2.) Blackifh brown bloodftone; *Hæmatites nigrefcens.* Kidney ore. This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadftone.
a. Solid, with a glaffy texture.
b. Radiated.
c. Cryftallifed.
1. In form of cones, from Siberia.
2. In form of concentric balls, with a facetted furface. Thefe are very common in Germany, but very fcarce in Sweden.

241 (3.) Red bloodftone; *Hæmatites ruber.* Red kidney ore.
a. Solid, and dim in its texture.
b. Scaly. The *eifenman* of the Germans. This is commonly found along with the iron-coloured iron glimmer, and fmears the hands.
c. Cryftallifed, in concentric balls, with a flat or facetted furface.

(4.) Yellow bloodftone; *Hæmatites flavus.*
a. Solid. 242
b. Fibrous, from Lamerhof in Bohemia. The varieties of the colours in the bloodftone are the fame with thofe produced in the calces of iron, made by dry or liquid menftrua, and afterwards expofed to different degrees of heat.

[2.] Iron in form of calx, mixed with heterogeneous fubftances. 243
A. With a calcareous earth. White fpathofe iron ore. The *ftablftein* of the Germans.
B. With a filiceous earth. The martial jafper of Sinople.
C. With a garnet earth. Garnet and cockle or fhirl.
D. With an argillaceous earth. The bole.
E. With a micaceous earth. Mica.
F. With manganefe.
G. With an alkali and phlogifton. Blue martial earth. Native Pruffian-like blue. 244
1. Loofe or powdery: found among the turf in the levels of the province of Skone; alfo in Sax Weiffenfels, and at Norvlanden in Norway, &c.
H. With an unknown earth, which hardens in water. Tarras; *Cementum.* 245
1. Loofe or granulated; *Terra Puzzolana:* from Naples and Civita Vecchia in Italy. This is of a reddifh brown colour, is rich in iron, and is pretty fufible.
2. Indurated; *Cementum induratum.* This is of a whitifh yellow colour, contains likewife a great deal of iron, and has the fame quality with the former, to harden foon in water, when mixed with mortar. This quality cannot be owing to the iron alone, but rather to fome particular modification of it occafioned by fome accidental caufes, becaufe thefe varieties rarely happen at any other places except where volcanos have been, or are yet in the neighbourhood. 246
I. Calx of iron, united with another unknown earth. The *tungften* of the Swedes. This is alfo, though improperly, called *white tin-grains.* This refembles the garnet-ftone, and the tin-grains; is nearly as heavy as pure tin; very refractory in the fire, and exceffively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 *per cent.* It is very difficultly diffolved by borax and alkaline falts, but melts very eafily with the microcofmic falt; giving a black flag: and for this reafon, this laft mentioned falt muft be 247

be employed in the experiments on this ſtone. It is found,

1. Solid and fine-grained.
   - *a.* Reddiſh or fleſh-coloured.
   - *b.* Yellow.
2. Spathoſe, and with an unctuous ſurface.
   - *a.* White.
   - *b.* Pearl-coloured. This kind of ſtone is very ſeldom met with, but in ſuch places where black-lead is common in the neighbourhood; and the hiſtory of the black lead, inſerted in the Memoirs of the Swediſh Academy of Sciences, gives reaſon to believe, that this may contain ſome tin; which merits further examination. Mr Cronſtedt has in the ſaid Memoirs communicated his experiments upon this kind of ſtone from Riddarſhyttan, and Biſpberget in Weſtmanland; as has alſo Mr Rinman, on a great number of other martial earths. See the Memoirs for the years 1751 and 1754.

248 *B.* Diſſolved or mineraliſed iron.

[1.] With ſulphur alone.

A. Perfectly ſaturated with ſulphur; *Ferrum ſulphure ſaturatum.* Marcaſite.

B. With very little ſulphur. Black iron ore. Iron ſtone.

This is either attracted by the loadſtone, or is a loadſtone itſelf attracting iron; it reſembles iron, and yields a black powder when rubbed.

(1.) Magnetic iron ore. The loadſtone, *Magnes.*
- *a.* Steel-grained, of a dim texture, from Hogberget in the pariſh of Gagnœf in Dalarne: it is found at that place almoſt to the day, and is of as great ſtrength as any natural loadſtones were ever commonly found.
- *b.* Fine grained, from Saxony.
- *c.* Coarſe-grained, from Spetalſgrufvan at Norberg, and Kierrgrufvan, both in the province of Weſtmanland. This loſes very ſoon its magnetical virtue.
- *d.* With coarſe ſcales, found at Sandſwœr in Norway. This yields a red powder when rubbed.

249 (2.) Refractory iron ore. This in its crude ſtate is attracted by the loadſtone.
- *a.* Giving a black powder when rubbed; *Tritura atra.* Of this kind are,
  1. Steel-grained.
  2. Fine-grained.
  3. Coarſe-grained. This kind is found in great quantities in all the Swediſh iron mines; and of this moſt part of the fuſible ores conſiſt, becauſe it is commonly found in ſuch kinds of rocks as are very fuſible: and it is as ſeldom met with in quartz as the hæmatites is met with in limeſtone.
- *b.* Rubbing into a red powder. Theſe are real hæmatites, that are ſo far modified by ſulphur or lime as to be attracted by the loadſtone.
  1. Steel-grained.
  2. Fine-grained. Emery. This is imported from the Levant: it is mixed with mica, is ſtrongly attracted by the loadſtone, and ſmells of ſulphur when put to the fire.
  3. Of large ſhining cubes.
  4. Coarſe, ſcaly. The *eiſenglimmer* or *eiſenman*, from Gellebeck in Norway.

     Theſe are very ſcarce in Sweden, moſt part of the Swediſh bloodſtones being pure, as has already been ſaid, and form that very profitable ore in Swediſh called *torrſten.*

[2.] With arſenic; *Ferrum arſenico mineraliſatum.* Called *miſpickel* by the Germans, and *plate mundic* in Cornwall. 250

[3.] With ſulphurated arſenic. Arſenical pyrites.

[4.] With vitriolic acid. Martial vitriol.

[5.] With phlogiſton. Martial coal ore.

[6.] With other ſulphurated and arſenicated metals. See theſe in their reſpective arrangements.

SECOND ORDER. *Semi-metals.*

There are but ſeven ſemi-metals yet diſcovered, viz.

I. Quickſilver, mercury; *Argentum vivum, mercurius, hydrargyrum.* 251

This diſtinguiſhes itſelf from all metals, by the following qualities:

- *a.* Its colour is white and ſhining, a little darker than that of ſilver.
- *b.* It is fluid in the cold, and diviſible by the leaſt force; but as it only ſticks to a few bodies, to which it has an attraction, it is ſaid that it does not wet.
- *c.* It is volatile in the fire.
- *d.* Its weight is next to that of the gold, viz. to water, as 13,593 : : 1000.
- *e.* It attracts the other ſemi-metals and metals, and unites with them all, except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called an *amalgamation.* This amalgamation, or mixtion of metallic bodies, according to the readineſs with which they unite or mix, is in the following progreſſion, viz. gold, ſilver, lead, tin, zinc, biſmuth, copper, iron, and the regulus of antimony: but the three latter, however, do not very readily amalgamate. The iron requires a ſolution of the vitriol of iron, as a medium to promote the union.
- *f.* It diſſolves in the ſpirit of nitre, out of which it is precipitated by a volatile alkali, and the common ſalt, in form of a white powder; but

if a fixed alkali is ufed, into a yellow powder or calx.

g. It diffolves in the oil of vitriol by a ftrong boiling.

h. It is not affected by the acid of common falt, unlefs it be previoufly diffolved by other acids; in which cafe only they unite with one another, and may be fublimed together, which fublimation is a ftrong poifon.

i. It unites with fulphur by grinding; and then produces a black powder called *æthiops mineralis*, which fublimes into a red ftriated body called *factitious cinnabar*.

k. The fulphur is again feparated from the quickfilver, by adding iron or lime, to which the fulphur attaches itfelf, leaving the quickfilver to be diftilled over in a metallic form; but if a fixed alkali is added to it, fome part of the quickfilver will remain in the refiduum, and in that cafe makes a liver of fulphur.

252 Quickfilver is found,

A. Native, or in a metallic ftate. This is found in the quickfilver mines at Idria in Friuli, or the Lower Auftria, in clay, or in a black flaty lapis ollaris, out of which it runs, either fpontaneoufly or by being warmed even in the hands. It has feveral times been found at Herr Sten's Bottn, in the mines of Salberg in Weftmanland, and fometimes alfo amalgamated with native filver.

253 *B.* Mineralifed,

(1.) With fulphur. Cinnabar; *Cinnabaris nativa.* This is of a red colour, and its fpecific gravity to water is as 7500 to 1000.

a. Loofe or friable cinnabar; looks like red ochre.

b. Indurated. Solid cinnabar. Is of a deep red colour; and, with refpect to its texture, is either,

1. Steel-grained:
2. Radiated:
3. Compofed of fmall cubes, or fcaly:
4. Chryftallifed,

a. In a cubical form; it is tranfparent, and deep red as a ruby.

254 (2.) With fulphur and copper; *Mercurius cupro fulphurato mineralifatus.* This is blackifh grey, of a glaffy texture, and brittle; crackles and fplits exceffively in the fire; and when the quickfilver and fulphur are evaporated, the copper is difcovered by its common opaque red colour in the glafs of borax, which, when farther forced in the fire, or diluted, becomes green and tranfparent.

255 II. Bifmuth; tin-glafs. *Vifmutum, bifmutum, marcafita officinalis.* It is,

a. Of a whitifh yellow colour.

b. Of a laminated texture, foft under the hammer, and neverthelefs very brittle.

c. Its fpecific gravity to water is, as 9,700 : : 1000.

d. It is very fufible; calcines and fcorifies like lead, if not rather eafier; and therefore it works on the cuppel. It is pretty volatile in the fire.

e. Its glafs or flag becomes yellowifh brown, and has the quality of retaining fome part of the gold, if that metal has been melted, calcined, and vitrified with it.

f. It may be mixed with the other metals, except cobalt and zinc, making them white and brittle.

g. It diffolves in aquafortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both thefe folutions with pure water, into a white powder, which is called *Spanifh white.* It is alfo precipitated by the acid of fea-falt; which laft unites with it, and makes the *vifmutum corneum.*

h. It amalgamates eafily with quickfilver. Other metals are fo far attenuated by the bifmuth, when mixed with it, as to be ftrained or forced along with the quickfilver through fkins or leather.

Bifmuth is found in the earth. 256

A. Native. This refembles a regulus of bifmuth, but confifts of fmaller fcales or plates.

1. Superficial, or in crufts.
2. Solid, and compofed of fmall cubes. This is found in and with the cobalt ore, at Schneeberg in Saxony, and other foreign places: likewife along with the copper ore, at Nyberget, in the parifh of Stora Skedwi, in the province of Dalarne.

B. In form of calx. 257

1. Powdery or friable; *Ochra vifmuti.* This is of a whitifh yellow colour; it is found in form of an efflorefcence, to the day, at Los in the province of Helfingland.

It has been cuftomary to give the name of *flowers of bifmuth* to the pale red calx of cobalt, but it is wrong; becaufe neither the calx of bifmuth, nor its folutions, become red, this being a quality belonging to the cobalt.

C. Mineralifed bifmuth. This is, with refpect to colour and appearance, like the coarfe teffelated potter's lead ore; but it confifts of very thin fquare plates or flakes, from which it receives a radiated appearance when broken croffwife. 258

1. With fulphur.

a. With large plates or flakes, from Baftnas at Riddarfhyttan, Bafringe and Stripas in Weftmanland.

b. With fine or fmall fcales, from Jacobsgrufvan at Riddarfhyttan, and the mines at Los in the parifh of Farila in Helfingland.

2. With fulphurated iron.

a. Of coarfe, wedge-like fcales, from Kongruben, at Gellebeck in Norway.

This mineralifed bifmuth ore yields a fine radiated regulus; for which reafon it has been ranked among the antimonial ores, by thofe who have not taken proper care to melt a pure regulus or deftitute of fulphur from it; while others, who make no difference between regules and pure metals, have ftill more pofitively afferted it to be only an antimonial ore.

III. Zinc; fpeltre. *Zincum.* 259

a. Its colour comes neareft to that of lead, but it does not fo eafily tarnifh.

b. It fhows a texture, when it is broken, as if it were compounded of flat pyramids.

c. Its

Semi-Metals. *Zinc.*

c. Its specific gravity to water is, as 6,900 or 7000 to 1000.

d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow; and if in an open fire, the calx rises in form of soft white flowers; but if in a covered vessel, with the addition of some inflammable, it is distilled in a metallic form; in which operation, however, part of it is sometimes found vitrified.

e. It unites with all the metals, except bismuth, and makes them volatile. It is, however, not easy to unite it with iron without the addition of sulphur. It has the strongest attraction to gold and copper, and this last metal acquires a yellow colour by it; which has occasioned many experiments to be made to produce new metallic compositions.

f. It is dissolved by all the acids: of these the vitriolic acid has the strongest attraction to it; yet it does not dissolve it, if it is not previously diluted with much water. The abundance of phlogiston in this semi-metal is perhaps the reason of its strong attraction to the vitriolic acid.

g. Quicksilver amalgamates easier with zinc than with copper, by which means it is separated from compositions made with copper.

h. It seems to become electrical by friction, and then its smaller particles are attracted by the loadstone; which effects are not yet perfectly investigated; but they may excite philosophers to make farther experiments, in order to discover whether the electrical power shews itself in the metals by being attracted by the loadstone, or whether the magnetic power can be exerted on other metals than iron.

260 Zinc is found,

A. In form of calx.

(1.) Pure.

a. Indurated.

1. Solid.

2. Crystallised.

This is of a whitish grey colour, and its external appearance is like that of a lead spar; it cannot be described, but is easily known by an experienced eye. It looks very like an artificial glass of zinc; and is found among other calamines at Namur, and in England.

(2.) Mixed.

A. With a martial ochre; *Ochra sive calx zinci martialis.*

1. Half indurated. Calamine; *Lapis calaminaris.*

a. Whitish yellow,

b. Reddish brown.

This seems to be a mouldered or weathered blende.

B. With a martial clay or bole.

C. With a lead ochre and iron.

261 *B.* Mineralised zinc.

(1.) With sulphurated iron. Blende, mock-lead, black-jack, mock-ore; *pseudogalena* and *blende* of the Germans.

A. Mineralised zinc in a metallic form. Zinc ore.

This is of a metallic blueish grey colour, neither perfectly clear as a potter's ore, nor so dark as the Swedish iron ores.

1. Of a fine cubical or scaly texture.

2. Steel-grained.

B. In form of calx. Blende. Mock-lead; *Sterile nigrum. Pseudogalena.* This is found, 262

1. With course scales,

a. Yellow; semi-transparent.

b. Greenish.

c. Black; *pechbende* or *pitch blende* of the Germans.

d. Blackish brown.

2. With fine scales,

a. White.

b. Whitish yellow.

c. Reddish brown.

3. Fine and sparkling; at Goslar called *braun bleyertz.*

a. Dark brown.

The zinc, in these last kinds of blendes, is as it were in form of a calx or glass, so that they are often transparent: on the contrary, in the zinc ore, (n° 261.) it seems rather to be in a metallic form, or, like most other metals, mineralised with sulphur. The sulphur, nevertheless, exists in the different kinds of blende, equally as in the zinc ore; and this remarkable difference in their appearance must be accounted for from another principle than the quantity of the zinc which they contain; because the yellow and white blendes are often found richer than the zinc ores; but the zinc ores are, however, more easy to melt, and consequently more profitable. Perhaps it is because the blende does not contain a sufficient quantity of the phlogiston of the sulphur, to prevent the calcination of the zinc.

It is no matter whether a calcined blende is called *calamine* or not, provided it has such properties that it may be employed to the same purposes, and with the same advantage, as that calamine which nature has freed from its sulphur by its weathering or decaying. This may be done with some kinds of blende; and Mr Von Swab has given evident and excellent proofs of it in Sweden; insomuch that it would demonstrate a want of experience to insist that sulphur cannot be expelled by calcination, without destroying the zinc itself, and that flowers of zinc may be produced from zinc ores in a calcining heat, without addition of any phlogiston.

Mr

Mr Jufti however avers, that he has found an ore of this quality, which in his Mineralogy he calls *Zinkfpat:* but there is great reafon to doubt if it really contains any zinc, until it is proved whether the author added any phlogifton during the calcination, or reduced the zinc out of it; becaufe, although the flowers of zink may not always be perfectly well calcined, yet there is no inftance of a natural zinc ore being difcovered, which by itfelf yields thofe flowers during the calcination: and it requires, befides, a ftrong heat to produce thefe flowers from a perfect calx or glafs of this femi-metal, either natural or artificial, though mixed with a phlogifton; for it could not have been a native zinc, fince it refembled a fpar, and fuch a one very likely is not to be found in nature.

263 IV. Antimony; *Antimonium Stibium.* This femimetal is,

a. Of a white colour almoft like filver.

b. Brittle; and in regard to its texture, it confifts of fhining planes, of greater length than breadth.

c. In the fire it is volatile, and volatilifes part of the other metals along with it, except gold and platina. It may, however, in a moderate fire, be calcined into a light grey calx, which is pretty refractory in the fire, but melts at laft to a glafs of a reddifh brown colour.

d. It diffolves in fpirit of fea-falt and aqua regia, but is only corroded by the fpirit of nitre into a white calx; it is precipitated out of the aqua regia by water.

e. It has an emetic quality when its calx, glafs, or metal, is diffolved in an acid, except when in the fpirit of nitre, which has not this effect.

f. It amalgamates with quickfilver, if the regulus, when fufed, is put to it; but the quickfilver ought for this purpofe to be covered with warm water: it amalgamates with it likewife, if the regulus of antimony be previoufly melted with an addition of lime.

264 Antimony is found in the earth.

A. Native.

This is of a filver colour, and its texture is compofed of pretty large fhining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the laft century; and fpecimens thereof have been preferved in collections under the name of an arfenical pyrites, until the mine-mafter Mr Von Swab difcovered its real nature, in a treatife he communicated to the Royal Academy of Sciences at Stockholm in the year 1748. Among other remarkable obfervations in this treatife, it is faid, firft, That this native antimony eafily amalgamated with quickfilver; doubtlefs, becaufe it was imbedded in a limeftone; fince, according to Mr Pott's experiments, an artificial regulus of antimony may, by means of lime, be difpofed to an amalgamation: Secondly, That when brought in form of a calx, it fhot into cryftals during the cooling.

B. Mineralifed antimony. 265

(1.) With fulphur.

This is commonly of a radiated texture, compofed of long wedge-like flakes or plates; it is nearly of a lead colour, and rough to the touch.

a. Of coarfe fibres.

b. Of fmall fibres.

c. Steel-grained, from Saxony and Hungary.

d. Cryftallifed, from Hungary.

1. Of a prifmatical, or of a pointed pyramidal figure, in which laft circumftance the points are concentrical.

Mr Cronftedt mentions a fpecimen of this, in which the cryftals were covered with very minute cryftals of quartz, except at the extremities, where there was always a little hole: this fpecimen was given for a *flos ferri* fpar.

(2.) With fulphur and arfenic. Red antimony ore; *Antimonium folare.* 266

This is of a red colour, and has the fame texture with the preceding, though its fibres are not fo coarfe.

a. With fmall fibres.

b. With abrupt broken fibres, from Braunfdorff in Saxony, and from Hungary.

All antimonial ores are fomewhat arfenical, but this is more fo than the preceding kinds.

(3.) With fulphurated filver. Plumofe filver-ore.

(4.) With fulphurated filver, copper, and arfenic.

(5.) With fulphurated lead.

V. Arfenic. This is, 267

a. In its metallic form, nearly of the fame colour as lead, but brittle, and changes fooner its fhining colour in the air, firft to yellow, and afterwards to black.

b. It appears laminated in its fractures, or where broken.

c. Is very volatile in the fire, burns with a fmall flame, and gives a very difagreeable fmell like garlic.

d. It is, by reafon of its volatility, very difficult to be reduced, unlefs it is mixed with other metals: However, a regulus may be got from the white arfenic, if it is quickly melted with equal parts of pot-afhes and foap; but this regulus contains generally fome cobalt, moft of the white arfenic being produced from the cobalt ores during their calcination. The white arfenic, mixed with a phlogifton, fublimes likewife into octoëdral cryftals of a metallic appearance, whofe fpecific gravity is 8,308.

e. The calx of arfenic, which always, on account of

Semi-Metals. *Arsenic.*

of its volatility, muſt be got as a ſublimation, is white, and eaſily melts to a glaſs, whoſe ſpecific gravity is 5,000. When ſulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called *orpiment* or yellow arſenic; *ſandarach, realgar*, or red arſenic; and alſo *rubinus arſenici*.

f. This calx and glaſs are diſſoluble in water, and in all liquids; though not in all with the ſame facility. In this circumſtance arſenic reſembles the ſalts; for which reaſon it alſo might be ranked in that claſs.

g. The regulus of arſenic diſſolves in ſpirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menſtrua.

h. It is poiſonous, eſpecially in form of a pure calx or glaſs: But probably it is leſs dangerous when mixed with ſulphur, ſince it is proved by experience, that the men at mineral works are not ſo much affected by the ſmoke of this mixture as by the ſmoke of lead; and that ſome certain nations make uſe of the red arſenic in ſmall doſes as a medicine.

i. It unites with all metals, and is likewiſe much uſed by nature itſelf to diſſolve, or, as we term it, to *mineraliſe*, the metals, to which its volatility and diſſolubility in water muſt greatly contribute. It is likewiſe moſt generally mixed with ſulphur.

k. It abſorbs or expels the phlogiſton, which has coloured glaſſes, if mixed with them in the fire.

Arſenic is found,

268 [1.] Native; called *Scherbencobolt* and *Fliegenſtein* by the Germans.

It is of a lead colour when freſh broken, and may be cut with a knife, like black lead, but ſoon blackens in the air. It burns with a ſmall flame, and goes off in ſmoke.

A. Solid and teſtaceous.

This is found in the mines of Saxony, the Hartz, and Hungary.

B. Scaly, at Kongſberg in Norway.

C. Friable and porous; *Fliegenſtein*.

(1.) With ſhining fiſſures.

This is by ſome called *Spigel cobolt, (minera cobalti ſpecularis)*, according to their notions of the affinity of theſe metals to one another. However, there always remains after the volatiliſation of the ſcherbencobolt, ſome calx, either of cobalt or biſmuth, and ſome ſilver, though in too ſmall a quantity to deſerve any notice.

(2.) In form of a calx.

A. Pure, or free from heterogeneous ſubſtances.

1. Looſe or powdery.
2. Indurated, or hardened. This is found in form of white ſemi-tranſparent cryſtals.

B. Mixed with ſulphur.

1. Hardened.

a. Yellow. Orpiment; *Auripigmentum*.

b. Red. Native realgar, or ſandarach.

The orpiment may perhaps be found naturally in looſe ſcaly powder, as it is ſometimes met with in the ſhops: however, the hardened ſort is ſeldom found but in collections.

Semi-Metals. *Cobalt.*

C. Mixed with the calx of tin, in the tin-grains.

D. With ſulphur and ſilver, in the rothgulden, or red ſilver ore.

E. With calx of lead, in the lead-ſpar.

F. With calx of cobalt, in the effloreſcence of cobalt.

[2.] Mineraliſed.

A. With ſulphur and iron. Arſenical pyrites or marcaſite. Theſe kinds in Cornwall are called *ſilvery* or *white mundics*, and *plate mundics*. 269

This alone produces red arſenic, when calcined, and is found in great quantities in the mines of Loras in the province of Dalarne: It is if a deeper colour than the following.

B. With iron only. This differs with regard to its particles, being,

1. Steel-grained;
2. Coarſe-grained, from Weſterſilſverberget;
3. Cryſtalliſed.

a. In an octoëdral figure. This is the moſt common kind.

b. Priſmatical. The ſulphureous marcaſite is added to this kind, when red arſenic is to be made; but in Sweden it is ſcarcer than the ſulphureous arſenical pyrites.

C. With cobalt, almoſt in all cobalt ores.

D. With ſilver.

E. With copper.

F. With antimony.

VI. Cobalt. 270

This ſemi-metal is,

a. Of a whitiſh grey colour, nearly as fine-tempered ſteel.

b. Is hard and brittle, and of a fine-grained texture; hence it is of a duſky, or not ſhining appearance.

c. Its ſpecific gravity to water is 6000 to 1000.

d. It is fixt in the fire, and becomes black by calcination; it then gives to glaſſes a blue colour, inclining a little to violet, which colour, of all others, is the moſt fixed in fire.

e. The concentrated oil of vitriol, aquafortis, and aqua-regia, diſſolve it; and the ſolutions become red. The cobalt calx is likewiſe diſſolved by the ſame menſtrua, and alſo by the volatile alkali and the ſpirit of ſea-ſalt.

f. When united with the calx of arſenic in a ſlow (not a briſk) calcining heat, it aſſumes a red colour: the ſame colour is naturally produced by way of efflorеſcence, and is then called the *bloom*, or *flowers of cobalt*. When cobalt and arſenic are melted together in an open fire, they produce a blue flame.

g. It does not amalgamate with quickſilver by any means hitherto known.

h. Nor does it mix with biſmuth, when melted with it, without addition of ſome medium to promote their union.

The cobalt is moſt commonly found in the earth mixed with iron.

A. In form of a calx.

(1.) With iron without arfenic.

a. Loofe or friable. Cobalt ochre. It is black, and like the artificial zaffre.

271 *b*. Indurated; the *fchlacken* or flag cobalt. This is likewife of a black colour, but of a glaffy texture; and feems to have loft that fubftance which mineralifed it, by being decayed or weathered. It is often confounded with the fcherbencobolt, for it is feldom quite free from arfenic; and there may perhaps exift a progreffive feries from the fchlacken kind to the fcherbencobolt kind.

272 (2.) With the calx of arfenic. Cobalt-blut; *Ochra cobalti rubra*; bloom, flowers, or efflorefcence, of cobalt.

a. Loofe or friable. This is often found of a red colour like other earths, fpread very thin on the cobalt ores, and is, when of a pale colour, erroneoufly called *flowers of bifmuth*.

b. Indurated. Hardened flowers of cobalt. This is commonly cryftallifed in form of deep red femi-tranfparent rays or radiations.

A white cobalt-earth, or ochre, is faid to have been found. It has been feen and examined by a celebrated mineralift, who has found it in every refpect, except the colour, to refemble the cobalt flowers; and it is very poffible that thofe cobalt flowers might in length of time have loft their red colour, and become white.

273 *B*. Mineralifed.

(1.) With arfenic and iron in a metallic form. This is of a dim colour when broken, and not unlike fteel. It is found,

a. Steel-grained.

b. Fine-grained,

c. Coarfe-grained.

d. Cryftallifed.

1. In a dendritical or arborefcent form.

2. Polyëdral, with fhining furfaces; the *glanzkobolt* of the Germans.

3. In radiated nodules.

274 (2.) With fulphurated iron. This is of a lighter colour than the preceding, nearly like to tin or filver. It is found,

A. Cryftallifed.

1. In a polygonal form.

a. Of a flaggy texture.

b. Coarfe-grained. This kind difcovers not the leaft mark of arfenic. The coarfe-grained becomes flimy in the fire, and fticks to the ftirring hook during the calcination, in the fame manner as many regules do; and is a kind of regule prepared by nature.

That fort of a flaggy texture is very martial, and is defcribed by the mine-mafter Mr Brandt, in the Acts of the Swedifh Academy of Sciences for the year 1746. Both thefe give a beautiful colour.

275 (3.) With fulphur, arfenic, and iron. This refembles the arfenicated cobalt ore, being only rather of a whiter or lighter colour. It is found,

a. Coarfe-grained.

b. Cryftallifed,

1. In a polygonal figure, with fhining furfaces, or *glanzkobolt*. It is partly of a white or light colour, and partly of a fomewhat reddifh yellow.

(4.) With fulphurated and arfenicated nickel and iron; fee n° 279. 276

VII. Nickel; *Niccolum*. This is the lateft difcovered femi-metal. It was firft defcribed by its 277 difcoverer Mr Cronftedt, in the Acts of the Royal Academy of Sciences at Stockholm for the years 1751 and 1754, where it is faid to have the following qualities: That,

1. It is of a white colour, which, however, inclines fomewhat to red.
2. Of a folid texture, and fhining in its fractures.
3. Its fpecific gravity to water is as 8,500 to 1000.
4. It is pretty fixt in the fire; but, together with the fulphur and arfenic, with which its ore abounds, it is fo far volatile as to rife in form of hairs and branches, if in the calcination it is left without being ftirred.
5. It calcines to a green calx.
6. This calx is not very fufible, but, however, tinges glafs of a tranfparent reddifh-brown or jacinth colour.
7. It diffolves in aquafortis, aqua regia, and the fpirit of fea-falt, but more difficultly in the vitriolic acid, tinging all thefe folutions of a deep green colour. Its vitriol is of the fame colour; but the colcothar of this vitriol, as well as the precipitates from the folutions, become by calcination of a light green colour.
8. Thefe precipitates are diffolved by the fpirit of fal ammoniac, and the folution has a blue colour; but being evaporated, and the fediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a ftrong attraction to fulphur; fo that when its calx is mixed with it, and put on a fcorifying teft under the muffel, it forms with the fulphur a regule: this regule refembles the yellow fteel-grained copper-ores, and is hard and fhining on its convex furface.
10. It unites with all the metals, except quickfilver and filver. When the nickel regulus is melted with the latter, it only adheres clofe to it, both the metals lying near one another on the fame plane; but they are eafily feparated with a hammer. Cobalt has the ftrongeft attraction to nickel, after that to iron, and then to arfenic. The two former cannot be feparated from one another but by their fcorification; which is eafily done, fince
11. This femi-metal retains its phlogifton a long time in the fire, and its calx is reduced by the help of a very fmall portion of inflammable matter: it requires, however, a red heat before it can be brought into fufion, and melts a little fooner, or almoft as foon as copper or gold, confequently fooner than iron.

The

The nickel is found.

A. In form of a calx. Nickel ochre.

278 1. Mixed with the calx of iron. This is green, and is found in form of flowers on Kupfer-nickel.

279 *B.* Mineralised nickel.

1. With sulphurated and arsenicated iron and cobalt. *Kupfernickel.* This is of a reddish yellow colour; and is found,

a. Of a flaggy texture, in Saxony.

b. Fine-grained; and

c. Scaly, in Loos cobalt-mines in the province of Helsingeland, at which place it is of a lighter colour than the foreign ones. These two are often from their colour confounded with the liver-coloured marcasite.

280 2. With the acid of vitriol. This is of a beautiful green colour, and may be extracted out of the nickel ochre, or efflorescence of the Kupfernickel.

Of Saxa and Petrifactions.

281 Though the *Saxa*, and fossils commonly called *petrifactions*, cannot be ranked in a mineral system, as consisting of principles already taken notice of; yet as these bodies, especially the latter, occupy so considerable a place in most mineral collections, and the former must necessarily be taken notice of by the miners in the observations they make in the subterranean geography, it appeared proper to subjoin them in such an order as may answer the purpose for which they are regarded by miners and mineralogists.

FIRST ORDER.

Saxa. *Petræ.*

282 These may be divided into two kinds.

1. Compound saxa, are stones whose particles, consisting of different substances, are so exactly fitted and joined together, that no empty space, or even cement, can be perceived between them; which seems to indicate, that some, if not all, of these substances have been soft at the instant of their union.

2. Conglutinated stones, are stones whose particles have been united by some cementitious substance, which, however, is seldom perceivable, and which often has not been sufficient to fill every space between the particles: in this case the particles seem to have been hard, worn off, and in loose, single, unfigured pieces, before they were united.

283 I. Compound saxa.

A. Ophites. Scaly limestone with kernels or bits of serpentine stone in it.

1. *Kolmord's marble.* It is white and green.

2. *Serpentino antico,* is white, with round pieces of black steatites in it. This must not be confounded with the *serpentino verde antico.*

3. The *Haraldsio marble.* White, with quadrangular pieces of a black steatites.

4. The *marmor pozzevera di Genoua.* Dark green marble, with white veins. This kind receives its fine polish and appearance from the serpentine stone.

284 *B. Stellsten* or *gestellstein; Saxum compositum particulis quartzosis & micaceis.*

1. Of distinct particles. In some of these the quartzose particles predominate, and in others the micaceous: in the last case it is commonly slaty, and easy to split.

2. Of particles which are wrapt up in one another.

a. Whitish grey.

b. Greenish.

c. Reddish. Both these kinds of stellsten are, for their resistance to the fire, employed in building furnaces; but the latter is the best, because it seems at the same time to contain a little of a refractory clayish substance: it, however, cracks very soon, if the flat side of the stratum, instead of the extremity, is turned towards the fire. It is also of great use in mills. It is lucky for œconomical purposes, that the plates of these stones are so thick, although thereby they are not so easily split.

C. Norrka. Murksten of the Swedes. *Saxum compositum micâ, quartzo, et granato.* 285

1. With distinct garnets or shirl.

a. Light grey.

b. Dark grey.

c. Dark grey, with prismatical, radiated, or fibrous cockle or shirl.

2. With kernels of garnet-stone.

a. Of pale red garnet-stone. The first of this kind, whose slaty strata makes it commonly easy to be split, is employed for mill-stones, which without difficulty distinguish themselves for that purpose, if sand is first ground with them, because the sand wears away the micaceous particles on the surfaces, and leaves the garnets prominent, which renders the stone fitter for grinding the corn.

D. The whetstone, *Cos. Saxum compositum micâ, quartzo, et forsan argillâ martiali in nonnullis speciebus.* 286

1. Of coarse particles.

a. White.

b. Light grey.

2. Of fine particles.

a. Liver-brown colour.

b. Blackish grey.

c. Light grey.

d. Black. The table-slate, or that kind used for large tables and for school-slates.

The naked eye, and the magnifying glass, much better discovers the micaceous particles in this kind to be as it were twisted in one another; some clay seems likewise to enter into the composition: however, it cannot yet be certainly asserted that it is real mica which has that appearance in this kind.

3. Of very minute and closely combined particles. The Turkey stone. This is of an olive colour, and seems to be the finest mixture of the first species of this genus. It is found in loose stones at Biorkskoginas in the parish of Hellefors in Westmanland, though not

not perfectly free from croſs veins of quartz, which always are in the ſurface of the rock, and ſpoil the whetſtones. It is alſo ſaid to be found in Tellemarken in Norway. The beſt of this ſort come from the Levant, and are pretty dear. The whetſtone kinds, when they ſplit eaſily, and in thin plates, are very fit to cover houſes with, tho' moſt of them are not uſed for that purpoſe.

E. The *telgſten* of the Swedes. *Lapis allaris. Saxum compoſitum ſteatite et micâ.*
- *a.* Light grey.
- *b.* Whitiſh yellow.
- *c.* Dark grey.
- *d.* Dark green. This is employed with great advantage to build fire-places and furnaces, &c. and when it is ſlaty, the extremities of the ſtrata muſt be turned towards the fire.

287 *F.* Porphyry; *Porphyrites.* Italorum *porfido. Saxum compoſitum jaſpide et feltſpato, interdum micâ et baſalte.*
- *a.* Its colour is green, with light green feltſpat, *Serpentino verde antico.* It is ſaid to have been brought from Egypt to Rome, from which latter place the ſpecimens of it now come.
- *b.* Deep red, with white feltſpat.
- *c.* Black, with white and red feltſpat.
- *d.* Reddiſh brown, with light-red and white feltſpat.
- *e.* Dark grey, with white grains of feltſpat alſo. Many varieties of this kind in regard to colour are found in form of nodules or looſe ſtones in Sweden; but we have only mentioned the hardeſt and fineſt of thoſe which are found in the rocks; becauſe, beſides theſe, there are coarſe porphyries found, which ſcarce admit of any poliſh. The dark red porphyry has been moſt employed for ornaments in building: yet it is not the only one known by the name of *porfido*, the Italians applying the ſame name alſo to the black kind.

288 *G.* The *trapp* of the Swedes. *Saxum compoſitum jaſpide martiali molli, ſeu argillâ martiali induratâ, et - - - -*

This kind of ſtone ſometimes conſtitutes or forms whole mountains; as, for example, the mountain called *Hunneberg* in the province of Weſtergottland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a ſerpentine manner, contrary or acroſs to the direction of the rock itſelf. It is not homogeneous, as may be plainly ſeen at thoſe places where it is not preſſed cloſe together; but where it is preſſed cloſe, it ſeems to be perfectly free from heterogeneous ſubſtances. When this kind is very coarſe, it is interſperſed with feltſpat; but it is not known if the finer ſorts likewiſe contain any of it. Beſides this, there are alſo ſome fibrous particles in it, and ſomething that reſembles a calcareous ſpar: this, however, does not ferment with acids, but melts as eaſy as the ſtone itſelf, which becomes a black ſolid glaſs in the fire. By calcination it becomes red, and yields in eſſays 12 or more *per cent.* of iron. No other ſort of ore is to be found in it, unleſs now and then ſomewhat merely ſuperficial lies in its fiſſures; for this ſtone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glaſs-houſes, and added to the compoſition of which bottles are made. By the Germans it is called *ſchwach* or *ſchwartsſtein;* at the Swediſh glaſs-works, *trappſkiol, tegelſkiol,* or *ſwartſkiol;* and at Jarlſberg in Norway, *blabeſt.* In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddiſh brown if made red-hot. It is found,

1. Of coarſe chaffy particles.
   - *a.* Dark grey.
   - *b.* Black.
2. Coarſe-grained.
   - *a.* Dark grey.
   - *b.* Reddiſh.
   - *c.* Deep brown.
3. Of fine imperceptible particles.
   - *a.* Black. The touchſtone; *Lapis lydius.*
   - *b.* Blueiſh.
   - *c.* Grey.
   - *d.* Reddiſh.

The black variety (3. *a.*) is ſometimes found ſo compact and hard, as to take a poliſh like the black agate: it melts, however, in the fire to a black glaſs; and is, when calcined, attracted by the loadſtone.

H. Amygdaloides. Saxum baſi jaſpideâ martiali, cum fragmentis ſpati calcarei et ſerpentini, figurâ ellipticâ. The carpolithi or fruit-ſtone rocks of the Germans. It is a martial jaſper, in which elliptical kernels of calcareous ſpar and ſerpentine ſtone are included. 289
- *a.* Red, with kernels of white limeſtone, and of a green ſteatites. This is of a particular appearance, and when calcined is attracted by the loadſtone; it decays pretty much in the air, and has ſome affinity with the trapp, and alſo with the porphyry. There are ſometimes found pieces of native copper in this ſtone.

I. The *gronſten* of the Swedes. *Saxum compoſitum micâ et hornblende.* Its baſis is hornblende, interſperſed with mica. It is of a dark green colour, and is dug in ſeveral places in Smoland, where it is employed in the iron furnaces as a flux to the bog ore. 290

K. The granites. *Saxum compoſitum feltſpata, micâ et quartzo, quibus accidentaliter interdum hornblende, ſteatites, granatus et baſaltes immixti ſunt.* Its principal conſtituent parts are feltſpat, or rhombic quartz, mica, and quartz. It is found, 291

(1.) Looſe or friable. This is uſed at the Swediſh braſs-works to caſt the braſs in, and comes from France.

(2.) Hard and compact.

a. Red.

a. Red.

1. Fine-grained.
2. Coarfe-grained.

b. Grey, with many and various colours. The granites are feldom flaty or laminated, when their texture is clofe, and the harder particles, as the felt-fpat or rhombic quartz, the quartz, and the fhirl, predominate in it. They admit of a good polifh; for which reafon the Egyptians in former times, and the Italians now, work them into large pieces of ornamental architecture; for which purpofe they are extremely fit, as they do not decay in the air.

292 II. Conglutinated faxa.

A. Of larger or broken pieces of ftones of the fame kinds conglutinated together. *Breccia.*

1. Of limeftone cemented by lime.

a. The calcareous breccia; *Breccia calcarea:* the *marmi brecciati* of the Italians.

When thefe kinds have fine colours, they are polifhed and employed for ornaments in architecture, and other œconomical ufes: they come from Italy.

b. The *lumachella* of the Italians, or fhell-marbles. Thefe are a compound of fhells and corals, which are petrified or changed into lime, and conglutinated with a calcareous fubftance. When they have many colours, they are called *marbles,* and employed for the fame purpofes as the preceding.

293 2. Of kernels of jafper cemented by a jafpery fubftance. *Breccia jafpidea. Diafpro brecciato* of the Italians. Of this kind fpecimens from Italy are feen in collections. A coarfe jafper breccia is faid to be found not far from Frejus in Provence in France.

294 3. Of filiceous pebbles, cemented by a jafpery fubftance, or fomething like it. The plum-pudding ftone of the Englifh. *Breccia filicea.* Its bafis, which at the fame time is the cement, is yellow, wherein are contained fingle flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polifhed; it is found in England.

295 4. Of quartzofe kernels combined with an unknown cement. *Breccia quartzofa.*

296 5. Of kernels of feveral different kinds of ftones. *Breccia faxofa.*

a. Of kernels of porphyry, cemented by a porphyry or coarfe jafpery fubftance; *Breccia porphyrea.*

b. Of kernels of feveral faxa; *Breccia indeterminata.* Is found in loofe ftones in Dalarne, and are originally broken from the Fiell tracts in Serna, which confift of nothing elfe but conglutinated ftones.

c. Of conglutinated kernels of fandftone; *Breccia arenacea.* This kind confifts of fandftone kernels, which have been combined a fecond time together.

The above-mentioned brecciæ of themfelves muft demand the diftinctions here made between, but which perhaps may feem to be carried too far, fince their particles are fo big and plain as to be eafily known from one another. Thefe ftones are a proof both of the fubverfions which the mountains in many centuries have undergone, and of fome of hidden means which nature makes ufe of in thus cementing different kinds of ftones together. Any certain bignefs for the kernels or lumps in fuch compounds, before they deferve the name of *breccia,* cannot be determined, becaufe that depends on a comparifon which every one is at liberty to imagine. At one place in the mountain called *Hykieberget,* the kernels of porphyry have a diameter of fix feet, while in other places they are no bigger than walnuts. At Maffewala, the kernels have a progreffive fize down to that of a fine fandftone. Moft of this kind of ftone is fit for ornaments, though the workmanfhip is very difficult and coftly.

B. Conglutinated ftones of granules or fands of different kinds. Sandftone; *Lapis arenaceus.* 297

In this divifion are reckoned thofe which confift of fuch minute particles, that all of them cannot eafily be difcovered by the naked eye. The greateft part, however, confift of quartz and mica; which fubftances are the moft fit to be granulated, without being brought to a powder.

1. Cemented by clay.

a. With an apyrous or refractory clay; is of a loofe texture, but hardens, and is very refractory in the fire.

b. With common clay; from Burfwick in the ifland of Gottland.

2. With lime; refembles mortar made with coarfe fand.

a. Confifting of tranfparent and greenifh grains of quartz and white limeftone.

b. Of no vifible particles. This is of a loofe texture, and hardens in the air.

3. With an unknown cement.

a. Loofe.
b. Harder.
c. Compact.
d. Very hard.

4. Cemented by the ruft or ochre of iron. Is found in form of loofe ftones at feveral places, and ought perhaps to be reckoned among the *mineræ arenaceæ* or fand-ores; at leaft when the martial ochre makes any confiderable portion of the whole.

C. Stones and ores cemented together; *Mineræ arenaceæ.* 298

1. Of larger fragments.

a. Mountain green, or *viride montanum cupni,* and pebbles cemented together, from Siberia.

b. Potters lead-ore, with limeftone.

c. Yellow or marcafitical copper ore, with fmall pebbles.

2. Of fmaller pieces. 299

Earthy changes, &c.

a. Potters lead-ore with a quartzose sand.
b. Mountain green with sand from Siberia.
c. Cobalt ore with sand.
d. Martial ochre with sand.

300 SECOND ORDER.

MINERAL CHANGES, or the PETRIFACTIONS.

Mineralia-Larvata, vulgò *Petrifacta*,

ARE mineral bodies in the form of animals or vegetables, and for this reason no others belong to this order than such as have been really changed from the subjects of the other two kingdoms of nature. There is more difficulty to determine the first point, viz. from when these bodies are to be styled petrifactions, than from when they cease to be such.

301 I. Earthy changes; *Terræ larvatæ. Terrificata.*
A. Extraneous bodies changed into a lime substance, or calcareous changes; *Larvæ calcareæ.*
(1.) Loose or friable. Chalky changes; *Cretæ larvatæ.*
a. In form of vegetables.
b. In form of animals.
1. Calcined or mouldered shells; *Humus conchaceus.*
(2.) Indurated; *Petrifacta calcarea.*
a. Changed and filled with solid lime-stone.
1. In form of animals.
2. In form of vegetables.
b. Changed into a calcareous spar; *Petrifacta calcarea spatosa.*
1. In form of animals.
2. In form of vegetables.

302 *B* Extraneous bodies changed into a flinty substance. Siliceous changes; *Larvæ siliceæ.* These are, like the flint,
(1.) Indurated.
a. Changed into flints.
1. Carnelians in form of shells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is said to be in the collection of Count Tessin.
3. Coralloids of white flint, *(Millepora).*
4. Wood of yellow flint.

303 *C* Extraneous bodies changed into clay. Argillaceous changes; *Larvæ argillaceæ.*
A. Loose and friable.
1. Of porcelane clay.
a. In form of vegetables.
A piece of white porcelane clay from Japan, with all the marks of the root of a tree, has been observed in a certain collection.
2. Indurated.
1. In an unknown clay.
a. In form of vegetables. *Osteocolla.* It is said to be changed roots of the poplar tree, and not to consist of any calcareous substance.
A sort of fossil ivory is said to be found, which has the properties of a clay; but it is doubtful if it is rightly examined.

304 II. Saline extraneous bodies, or such as are penetrated by mineral salts. *Corpora peregrina insalita. Larvæ insalitæ.*

Metallic changes, &c.

A. With the vitriol of iron.
1. Animals.
a. Human bodies have been twice found in the mine at Falun in Dalarne; the last was kept a good many years in a glass-case, but began at last to moulder and fall to pieces.
2. Vegetables.
a. Turf, and
b. Roots of trees.
These are found in water strongly impregnated with vitriol. They do not burn with a flame, but only like a coal in a strong fire; neither do they decay in the air.

III. Extraneous bodies penetrated by mineral inflammable substances, or mineral phlogiston. 305
A. Penetrated by the substance of pit-coals.
1. Vegetables, which commonly have been woods, or appertaining to them.
a. Fully saturated. *Gagas.* Jet.
The jet is of a solid shining texture.
b. Not perfectly saturated; *Mumia vegetabilis.* Is loose; resembles umbre, and may be used as such.
B. Penetrated by rock-oil or asphaltum. 306
1. Vegetables.
a. Turf.
The Egyptian mummies cannot have any place here, since art alone is the occasion that those human bodies have in length of time been penetrated by the asphaltum, in the same manner as has happened naturally to the wood in pit-coal strata.
C. Penetrated by sulphur which has dissolved iron, or by marcasite and pyrites; *Pyrite impregnata. Petrifacta pyritacea.* 307
1. Human.
a. Bivalves,
b. Univalves,
c. Insects.

IV. Metals in form of extraneous bodies; *Larvæ metalliferæ.* 308
A. Silver; *Larvæ argentiferæ.*
(1.) Native.
a. On the surfaces of shells.
(2.) Mineralised with copper and sulphur.
a. Fahlertz, or grey silver ore in form of ears of corn, &c. and supposed to be vegetables, are found in argillaceous slate at Frankenberg and Tahlitteren in Hesse.
B. Copper; *Larvæ cupriferæ.*
(1.) Copper in form of calx. 309
a. In form of animals, or of parts belonging to them.
1. Ivory, and other bones of the elephant. The Turcois or Turkey stone. It is of a blueish green colour, and much valued in the east.
At Simore in Languedoc bones of animals are dug, which during the calcination assume a blue colour; but it is not

Changes from Decompofition.

not probable that the blue colour is owing to copper.

310 (2.) Mineralifed copper, which impregnates extraneous bodies; *Cuprum mineralifatum corpora peregrina ingreffum.*

A. With fulphur and iron. The yellow or marcafitical copper-ore that impregnates,

1. Animals.

a. Shells.

b. In form of fifh.

B. With fulphur and filver. Grey filver-ore or fahlerts, like ears of corn, from the flate-quarries in Heffe.

311 *C.* Changes into iron; *Larvæ ferriferæ.*

(1.) Iron in form of calx, which has affumed the place or the fhape of extraneous bodies; *Ferrum calciforme corpora peregrina ingreffum.*

a. Loofe; *Larvæ ochraceæ.*

1. Of vegetables.

Roots of trees, from the lake Langelma in Finland. See the acts of the Swedifh Academy of Sciences for the year 1742.

b. Indurated; *Larvæ hæmatiticæ.*

1. Of vegetables.

312 (2.) Iron mineralifed, affuming the fhape of extraneous bodies.

a. Mineralifed with fulphur. Marcafite. *Larvæ pyritaceæ.*

313 V. Extraneous bodies decompofing, or in a way of deftruction; *Corpora peregrina in gradibus deftructionis confiderata.* Mould; *Humus.* Turf; *Turba.*

A. From animals. Animal-mould; *Humus animalis.*

1. Shells. *Humus conchaceus.*

2. Mould of other animals; *Humus diverforum animalium.*

B. Vegetable mould; *Humus vegetabilis.*

1. Turf; *Turba.*

a. Solid, and hardening in the air; *Turba folida aëre indurefcens.*—Is the beft of this kind to be ufed for fuel, and comes neareft to the pit-coals. It often contains a little of the vitriolic acid.

b. Lamellated turba; *Turba foliata.* This is in the firft degree of deftruction.

2. Mould of lakes; *Humus lacuftris.* This is a black mould which is edulcorated by water.

3. Black mould; *Humus ater.*

This is univerfally known, and covers the furface of that loofe earth in which vegetables thrive beft.

314 THIRD ORDER. NATURAL SLAGS. *Scoriæ Vulcanorum.*

Slags.

SLAGS are found in great abundance in many places in the world, not only where volcanoes yet exift, but likewife where no fubterraneous fire is now known: Yet, in Mr Cronftedt's opinion, they cannot be produced but by means of fire. Thefe are not properly to be called *natural*, fince they have marks of violence, and of the laft change that mineral bodies can fuffer without the deftruction of the world; nor are they *artificial*, according to the univerfally-received meaning of this word. When we, perhaps, in future times, by new-difcovered means, may be able to find out of what fort of earth ftones are compounded, we fhall ftill be forced to ftop at the furface of them, and be contented with knowing that they contain a little iron.

A. Iceland agate; *Achates iflandicus niger.* 315

It is black, folid, and of a glaffy texture; but in thin pieces it is greenifh and femi-tranfparent like glafs-bottles, which contain much iron. The moft remarkable is, that fuch large folid maffes are found of it, that there is no poffibility of producing the like in any glafs-houfe.

It is found in Iceland, and in the ifland of Afcenfion: The jewellers employ it as an agate, though it is too foft to refift wear.

B. Rhenifh millftone; *Lapis molaris Rhenanus.* 316

Is blackifh-grey, porous, and perfectly refembles a fort of flag produced by mount Vefuvius.

C. Pumice-ftone; *Pumex.* 317

Is very porous and bliftered, in confequence of which it is fpecifically very light. It refembles that frothy flag which is produced in our iron furnaces.

1. White.

2. Black.

The colour of the firft is perhaps faded or bleached, becaufe the fecond kind comes in that ftate from the laboratory itfelf, viz. the volcanoes.

D. Pearl flag; *Scoriæ conftantes globulis vitreis conglomeratis.* 318

Is compounded of white and greenifh glafs particles, which feem to have been conglutinated while yet foft, or in fufion. Found on the ifle of Afcenfion.

E. Slag-fand or afhes; *Scoriæ pulverulentæ cineres vulcanorum.* 319

This is thrown out from volcanoes in form of larger or fmaller grains. It may perhaps be the principle of the Terra Puzzolana, becaufe fuch an earth is faid at this time to cover the ruins of Herculaneum near Naples, which hiftory informs us was deftroyed by a volcano during an earthquake.

MINERVA, or PALLAS, in Pagan worfhip, the goddefs of fciences and of wifdom, fprung completely armed from Jupiter's brain; and on the day of her nativity it rained gold at Rhodes. She difputed with Neptune the honour of giving a name to the city of Athens; when they agreed that whofoever of them fhould produce what was moft ufeful to mankind, fhould have that advantage. Neptune, with a ftroke of his trident, formed a horfe; and Minerva caufed an olive to fpring from the ground, which was judged to be moft ufeful, from its being the fymbol of peace. Minerva changed Arachne into a fpider, for pretending

to

to excel her in making tapeſtry. She fought the giants; favoured Cadmus, Ulyſſes, and other heroes; and refuſed to marry Vulcan, chooſing rather to live in a ſtate of celibacy. She alſo deprived Tireſias of ſight, turned Meduſa's locks into ſnakes, and performed ſeveral other exploits.

Minerva is uſually repreſented by the poets, painters, and ſculptors, completely armed, with a compoſed but agreeable countenance, bearing a golden breaſt-plate, a ſpear in her right-hand, and her ægis or ſhield in the left, on which is repreſented Meduſa's head encircled with ſnakes, and her helmet was uſually entwined with olives.

Minerva had ſeveral temples both in Greece and Italy. The uſual victim offered her was a white heifer, never yoked. The animals ſacred to her were the cock, the owl, and the baſiliſk.

MINERVÆ *Caſtrum*, *Arx Minervæ*, *Minervium*, or *Templum Minervæ*, (anc. geogr.), a citadel, temple, and town on the Ionian ſea, beyond Hydrus; ſeen a great way out at ſea. Now *Caſtro*, a town of Otranto in Naples. E. Long. 19. 25. N. Lat. 46. 8.

MINERVÆ *Promontorium* (anc. geogr.), the ſeat of the Sirens, a promontory in the Sinus Paeſtanus, the ſouth boundary of Campania on the Tuſcan coaſt; ſo called from a temple of Minerva on it: ſituate to the ſouth of Surrentum, and therefore called *Surrentinum*. Now *Capo della Minerva*, on the weſt coaſt of Naples, over-againſt the iſland Capri.

MINERVALIA, in Roman antiquity, feſtivals celebrated in honour of Minerva, in the month of March; at which time the ſcholars had a vacation, and uſually made a preſent to their maſters, called from this feſtival *minerval*.

MINGRELIA, anciently COLCHIS, a part of Weſtern Georgia, in Aſia; bounded on the eaſt by Iberia, or *Georgia* properly ſo called; on the weſt, by the Euxine Sea; on the ſouth, by Armenia, and part of Pontus; and on the north, by Mount Caucaſus.

Colchis, or Mingrelia, is watered by a great many rivers; as the Corax, the Hippus, the Cyaneus, the Chariſtus, the Phaſis, where the Argonauts landed, the Abſarus, the Ciſſa, and the Ophis, all emptying themſelves into the Euxine Sea. The Phaſis does not ſpring from the mountains in Armenia, near the ſources of the Euphrates, the Araxes, and the Tigris, as Strabo, Pliny, Ptolemy, Dionyſius, and after them Arrian, Reland, Calmet, and Sanſon, have falſely aſſerted; but riſes on Mount Caucaſus; and flows not from ſouth to north, but from north to ſouth, as appears from the map of Colchis or Mingrelia in Thevenot's collection, and the account which Sir John Chardin gives of that country. This river forms in its courſe a ſmall iſland, called alſo *Phaſis;* whence the pheaſants, if Iſidorus is to be credited, were firſt brought to Europe, and thence called by the Greeks *Phaſiani*. The other rivers of Colchis are not conſiderable.

The whole kingdom of Colchis was in ancient times very pleaſant and fruitful, as it is ſtill where duly cultivated; abounded in all the neceſſaries of life; and was enriched with many mines of gold, which gave occaſion to the fable of the Golden Fleece and the Argonautic expedition ſo much celebrated by the ancients.

The lateſt account we have of this country is from Sir John Chardin, who tells us, that its length is above 100 miles, and its breadth 60; being not near ſo extenſive as the ancient Colchis, which reached from the frontiers of Iberia or Georgia Proper, weſtward to the Palus Mæotis: that it is beautifully diverſified with hills, mountains, valleys, woods, and plains, but badly cultivated: that there are all the kinds of fruits which are found in England, growing wild, but taſteleſs and inſipid for want of culture: that, if the natives underſtood the art of making wines, thoſe of this country would be the fineſt in the world: that there are many rivers which have their ſource in Mount Caucaſus, particularly the Phaſis, now called the *Rione:* that the country abounds in beeves, hogs, wild boars, ſtags, and other veniſon; and in partridges, pheaſants, and quails: that falcons, eagles, pelicans, lions, leopards, tigers, wolves, and jackals, breed on Mount Caucaſus, and ſometimes greatly annoy the country: that the people are generally handſome, the men ſtrong and well made, and the women very beautiful; but both ſexes very vicious and debauched: that they marry their nieces, aunts, or other relations, indifferently; and take two or three wives if they pleaſe, and as many concubines as they will: that they not only make a common practice of ſelling their children, but even murder them, or bury them alive, when they find it difficult to bring them up: that the common people uſe a ſort of paſte, made of a plant called *gom*, inſtead of bread; but that that of the better ſort conſiſts of wheat, barley, or rice: that the gentry have an abſolute power over their vaſſals, which extends to life, liberty, and eſtate: that their arms are the bow and arrow, the lance, the ſabre or broad-ſword, and the buckler: that they are very naſty; and eat ſitting croſs-legged upon a carpet, like the Perſians; but the poorer ſort upon a mat or bench, in the ſame poſture: that the country is very thin of inhabitants, no leſs than 12,000 being ſuppoſed to be ſold yearly to the Turks and Perſians: that the principal commodities exported from it are, honey, wax, hides, caſtor, martinſkins, flax-ſeed, thread, ſilk, and linen-cloth; but that there are no gold or ſilver mines now, and very little money: that the revenue of the prince or viceroy, amounts to about 20,000 crowns *per annum:* that the inhabitants call themſelves *Chriſtians;* but that both they and their prieſts are altogether illiterate, and ignorant of the doctrines and precepts of Chriſtianity: that there biſhops are rich, have a great number of vaſſals, and are cloathed in ſcarlet and velvet: and that their ſervice is according to the rites of the Greek church, with a mixture of Judaiſm and Paganiſm.

The cities of moſt note in this country in ancient times were Pityus; Dioſcurias, or Dioſcorias, which was ſo called from Caſtor and Pollux, two of the Argonauts, by whom it is ſuppoſed to have been founded, and who in Greek are ſtyled *Dioſcuroi*, at preſent known by the name of *Savatapoli;* Aea on the Phaſis, ſuppoſed to be the ſame as Hupolis; *Phaſis*, ſo called from the river on which it ſtood; Cyta, at the mouth of the river Cyaneus, the birth-place of the famous Medea, called from thence, by the poets, *Cytæis;* Saraceæ, Zadris, Surium, Madia, and Zoliſſa. As for modern cities, it does not appear that there are any here

here confiderable enough to merit a defcription; or, if there are, they feem to be little, if at all, known to Europeans.

MINHO, a great river in Spain, which taking its rife in Galicia, divides that province from Portugal, and falls into the Atlantic at Caminha.

MINIATURE, in a general fenfe, fignifies reprefentation in a fmall compafs, or lefs than the reality.

MINIATURE-PAINTING;

A DELICATE kind of painting, diftinguifhed from every other fpecies of that art by the following particulars. 1. It is more delicate. 2. It requires a nearer view. 3. It is not eafily done but in little. 4. It is wrought only upon vellum, paper, or ivory; and the colours are diluted only with gum-water.

SECT. I. *Of Drawing and Defigning.*

To fucceed in this art, a man fhould be perfectly fkilled in the art of defigning or drawing: but as moft people who affect the one, know little or nothing of the other, and would have the pleafure of painting, without giving themfelves the trouble of learning to defign, (which is indeed an art that is not acquired without a great deal of time, and continual application), inventions have been found out to fupply the place of it; by means of which a man defigns or draws, without knowing how to defign.

The firft is chalking: that is, if you have a mind to do a print or defign in miniature, the back-fide of it, or another paper, muft be blackened with fmall-coal, and then rubbed very hard with the finger wrapped in a linen cloth: afterwards the cloth muft be lightly drawn over the fide fo blackened that no black grains may remain upon it to foil the vellum you would paint upon; and the print or draught muft be faftened upon the vellum with four pins, to keep it from fhifting. And if it be another paper that is blackened, it muft be put between the velom and the print, or draught, with the blackened fide upon the vellum. Then, with a blunted pin or needle, you muft pafs over the principal lines or ftrokes of the print, or draught, the contours, the plaits of the drapery, and over every thing elfe that muft be diftinguifhed; preffing fo hard, that the ftrokes may be fairly marked upon the velom underneath.

Copying by fquares is another convenient method for fuch as are but little fkilled in the art of defigning, and would copy pictures, or other things, that cannot be chalked. The method is this: The piece muft be divided into many equal parts by little fquares, marked out with charcoal, if the piece be clear and whitifh, and the black can be fairly feen upon it; or with white chalk, if it be too brown and dufky. After which, as many fquares of equal dimenfions muft be made on white paper, upon which the piece muft be defigned; becaufe, if this be done immediately upon velom, (as one is apt to mifcarry in the firft attempt), the vellum may be foiled with falfe touches. But when it is neatly done upon paper, it muft be chalked upon the vellum in the manner before defcribed. When the original and the paper are thus ordered, obferve what is in each fquare of the piece to be defigned; as a head, an arm, a hand, and fo forth; and place it in the correfponding part of the paper. And thus finding where to place all the parts of the piece, you have nothing to do but to form them well, and to join them together. By this method you may reduce or enlarge a piece to what compafs you pleafe, making the fquares of your paper greater or leffer than thofe of the original; but they muft always be of an equal number.

To copy a picture, or other thing, in the fame fize and proportion, another method is, to make ufe of varnifhed paper, or of the fkin of a hog's bladder, very tranfparent, fuch as is to be had at the gold-beaters. Talc or ifinglafs will likewife do as well. Lay any one of thofe things upon your piece; through it you will fee all the ftrokes and touches; which are to be drawn upon it with a crayon or pencil. Then take it off; and faftening it under paper or velom, fet up both againft the light in the manner of a window; and with a crayon, or a filver needle, mark out upon the paper or vellum you have put uppermoft, all the lines and touches you fhall fee drawn upon the varnifhed paper, bladder, talc, or ifinglafs, you have made ufe of, and which will plainly appear through this window.

After this manner, making ufe of the window, or of glafs expofed to the light, you may copy all forts of prints, defigns, and other pieces, on paper or velom; laying and faftening them under the paper or velom upon which you would draw them. And it is a very good and a very eafy contrivance for doing pieces of the fame fize and proportion.

If you have a mind to make pieces look another way, there is nothing to be done but to turn them; laying the printed or drawn fide upon the glafs, and faftening the paper or velom upon the back of it; remembering to let your lights fall on the left fide.

A good method likewife to take a true copy of a picture in oil, is to give a touch of the pencil upon all the principal ftrokes, with lake tempered with oil; and to clap upon the whole a paper of the fame fize: then paffing the hand over it, the touches of the lake will ftick and leave the defign of your piece expreffed upon the paper, which may be chalked like other things. But you muft remember to take off with the crumb of bread what remains of the lake upon the picture before it be dry.

You muft likewife make ufe of pounce, made of powdered charcoal put in a linen-rag; with which the piece you would copy muft be rubbed, after you have pricked all the principal ftrokes or touches, and faftened white paper or vellum underneath.

But a furer and eafier help than all thefe for one who knows nothing of defigning, is a mathematical compafs; it is generally made of ten pieces of wood, in form of rulers, half a quarter of an inch thick, half an inch broad, and a foot long, or more, according as you have a mind to draw pieces of a greater or leffer fize. To facilitate the conftruction of this inftrument, a figure is given, with an explanation of the manner in which it is to be ufed. See Plate CLXXXIII. fig. 4.

The little board A is to be of fir, and covered with linen,

Of Colours.

linen, or any other cloth; becaufe the piece you copy, and the vellum or paper you copy upon, muft be fixed upon it. Upon this board muft the compafs alfo be fixed with a pin, by the end of the firft foot B, deep enough to keep it clofe, but not fo deep as to hinder it from turning eafily. When you have a mind to reduce things, place your original on the fide of the foot C, and the vellum or paper you would draw upon on the fide of the foot B; removing the vellum or drawing it nearer, according as you intend to reduce or enlarge.

In order to enlarge a piece, you have nothing to do but to change the places of your original and your copy; placing the laft towards C, and the other on the fide of B.

And in both one and the other method, a crayon or leaden needle muft be put in the foot under which the vellum lies; and a pin, a little blunted, in that over the original, with which all the traces are to be followed; conducting the pin with one hand, and with the other preffing gently upon the crayon or needle that marks the vellum. When the crayon or needle bears fufficiently upon the vellum, you have no occafion to touch it

By this inftrument you may alfo drawn in equal dimenfions: but in order to this, the compafs muft be fixed in another manner upon the board; for if it is to be faftened upon it by the middle at D, and your original and your copy muft be fixed on each fide of this middle foot, at the equal diftances, or from corner to corner; that is, from C to E, when the pieces are large. One may likewife draw feveral copies at once of equal and different dimenfions.

When your piece is marked out upon the vellum, you muft pafs with a pencil of very clear carmine over all the traces, to the end they may not be effaced as you work: then clean your vellum with the crumb of bread, that no black may remain upon it.

Your vellum muft be pafted upon a little plate of brafs or wood, of the fize you would make your piece, to keep it firm and tight: but this pafting muft be on the edges of your vellum only, and behind the plate; for which purpofe your vellum muft exceed your plate above an inch on every fide: for the part you paint upon muft never be pafted; becaufe it would not only give it an ill look, but you could not take it off if you would. Cut off the little fhags and locks of the velom; and wetting the fair fide with a linen-cloth, dipped in water, clap the other upon the plate with a clean paper between them: fo much as hangs over muft be pafted upon the back of the plate, drawing it equally on all fides, and hard enough to ftretch it well.

Sect. II. *Of Materials.*

The chief colours made ufe of for painting in miniature, are

Carmine.
Venice and Florence lake.
Rofe pink.
Vermilion.
Red-lead.
Brown red.
Red orpiment.
Ultramarine.
Verditer.
Indigo.
Gall-ftone.
Yellow-ochre.
Dutch pink.
Gamboge.
Naples yellow.
Pale mafticot.
Deep yellow mafticot.
Ivory-black.
Lamp-black.
True Indian ink.
Biftre, or wood-foot.
Raw umber.
Burnt umber.
Sap-green.
Verdigrife.
Flake-white.
Crayons of all colours.
Gold and filver fhells.
Leaf-gold and leaf-filver.

The feven tranfparent colours, which are ufed where writing is feen through the colour.

Liquid { Lake. Blue. Yellow. Grafs-green. Dark-green. Purple-colour. Brown.

Moft of thefe colours neceffary for miniature-painting may eafily be prepared by attending to the directions given under the article Colour-*Making*.

As colours taken from earth and other heavy matter are always too coarfe, be they never fo well ground, efpecially for delicate work, becaufe of a certain fand remaining in them; the fineft parts may be drawn out by diluting them with the finger in a cup of water. When they are well fteeped, let them fettle a while: then pour out the cleareft, which will be at top, into another veffel. This will be the fineft, and muft be let dry; and when it is ufed, muft be diluted with gum-water.

If you mix a little of the gall of an ox, a carp, or an eel, particularly of the laft, in green, black, grey, yellow, and brown, colours, it will not only take away their greafy nature, but alfo give them a luftre and brightnefs they have not of themfelves. The gall of eels muft be taken out when they are fkinned, and hung upon a nail to dry; and when you would ufe it, it muft be diluted with brandy; add a little of it mixed with the colour you have diluted already. This likewife makes the colour ftick better to the velom, which it hardly does when it is greafy: moreover, this gall hinders it from fcaling,

Some colours are made clearer by fire, as yellow ochre, brown red, ultramarine, and umber: all others are darkened by it. But if you heat the faid colours with a fharp fire, they change; for the brown red becomes yellow; yellow ochre becomes red; umber reddens alfo. Cerufs by fire takes the colour of citron, and is often called *mafticot*. Obferve, that yellow ochre heated, becomes more tender than it was, and fofter than brown red. Likewife brown red heated becomes fofter than fine yellow ochre. Both are very proper. The fineft and trueft ultramarine, heated upon a redhot

Colours, &c.

hot iron, becomes more glittering; but it waftes, and is coarfer and harder to work with in miniature.

All thefe colours are diluted in little cups of ivory, made on purpofe, or in fea fhells, with water in which gum-arabic and fugar-candy are put. For inftance, in a glafs of water put a piece of gum as big as a walnut, and half that quantity of fugar-candy. This laft hinders the colours from fcaling when they are laid on, which they generally do when they want it, or the vellum is greafy.

This gum-water muft be kept in a neat bottle corked; and you never muft take any out of it with a pencil that has colour upon it, but with a quill or fome fuch thing.

Some of this water is put in the fhell with the colour you would temper, and diluted with the finger till it be very fine. If it be too hard, you muft let it foften in the fhell with the faid water before you dilute it. Afterwards let it dry: and do thus with every colour, except lily-green, fap-green, and gamboge, which muft be tempered with fair water only. But ultramarine, lake, and biftre, are to be more gummed than other colours.

If you make ufe of fea-fhells, you muft let them fteep two or three days beforehand in water: then cleanfe them in boiling-hot water, mixed with vinegar, in order to carry off a certain falt, which otherwife fticks to them, and fpoils the colours that are put to them.

To know whether colours are fufficiently gummed, you have nothing to do but to give a ftroke of the pencil upon your hand when they are diluted, which dries immediately: if they chap and fcale, there is too much gum; if they rub out by paffing the finger over them, there is too little. It may be feen likewife when the colours are laid on the vellum, by paffing the finger over them. If they ftick to it like a powder, it is a fign there is not gum enough, and more muft be put to the water with which you temper them: but take care you do not put too much; for that makes the colour extremely hard and dry. It may be known likewife by their glueinefs and brightnefs: fo the more they are gummed, the darker they paint; and when you have a mind to give a greater ftrength to a colour than it has of itfelf, you have nothing to do but to give it a great deal of gum.

Provide yourfelf with an ivory pallet, very fmooth, as big as your hand; on one fide of which the colours for the carnation, or naked parts of a picture, are to ranged in the following manner. In the middle put a great deal of white, pretty largely fpread; becaufe it is the colour moft made ufe of: and upon the edge, from the left to the right, place the following colours at a little diftance from the white.

- Mafticot.
- Dutch pink.
- Orpiment.
- Yellow-ochre.
- Green; compofed of verditer, Dutch pink, and white, in equal quantities.
- Blue; made of ultramarine, Indigo, and white, to a great degree of palenefs.
- Vermilion.
- Carmine.
- Biftre, and
- Black.

On the other fide of the pallet, fpread fome white in the fame manner as for the carnation. And when you have a mind to paint draperies, or other things, place near the white the colour you would make them of, in order to work as fhall be fhewn hereafter.

The ufe of good pencils is a great matter. In order to make a good choice, wet them a little; and if the hairs keep clofe together as you turn them upon the finger, and make but one point, they are good: but if they clofe not together, but make feveral points, and fome are longer than others, they are good for nothing. When they are too fharp-pointed, with only four or five hairs longer than the reft, yet clofing all together, they are, notwithftanding, good; but they muft be blunted with a pair of fciffars, taking care at the fame time you do not clip away too much. It is proper to have two or three forts of them; the largeft for laying the grounds and dead-colouring, and the fmalleft for finifhing.

To bring the hairs of your pencil to join clofe together and make a good point, you muft often put the pencil juft between your lips when you are at work; moiftening and preffing it clofe with the tongue, even when there is colour upon it; for if there be too much, fome of it is taken off by this means, and enough left for giving fine and equal touches. You need not apprehend this will do you any harm. None of the colours for miniature, except orpiment, when they are prepared, have either ill tafte or ill quality. This expedient muft efpecially be ufed for dotting, and for finifhing, particularly the naked parts of a picture, that the touches may be neat and fair, and not too much charged with colour. As for draperies and other things, as well in dead-colouring as in finifhing, it is fufficient, in order to make the hairs of your pencil join well, and to unload it when it has too much colour, to draw it upon the edge of the fhell, or upon the paper you muft put upon your work to reft your hand on, giving fome ftrokes upon it before you work upon your piece.

To work well in miniature, you muft do it in a room that has but one window, and fix yourfelf very near it, with a table and defk almoft as high as the window; placing yourfelf in fuch a manner, that the light may always come in on the left fide, and never forward or on the right.

When you would lay a colour on all parts equally ftrong, as for a ground, you muft make your mixtures in fhells, and put in enough for the thing you defign to paint; for if there be not enough, it is a great chance but the colour you mix afterwards is too dark or too light.

Sect. III. *Of Working.*

After having fpoke of vellum, pencils, and colours, let us now fhew how they are to be employed. In the firft place, then, when you would paint a piece, be it carnation, drapery, or any thing elfe, you muft begin by dead-colouring; that is to fay, by laying your colours on with liberal ftrokes of the pencil, in the fmootheft manner you can, as the painters do in oil; not giving it all the force it is to have for a finifhing: that

Of Working.

that is, make the lights a little brighter, and the ſhades leſs dark, than they ought to be; becauſe in dotting upon them, as you muſt do after dead-colouring, the colour is always fortified, and would at laſt be too dark.

There are ſeveral ways of dotting; and every painter has his own. Some make their dots perfectly round. Others make them a little longiſh. Others hatch by little ſtrokes that croſs each other every way, till the work appears as if it had been wrought with dots. This laſt method is the beſt, the boldeſt, and the ſooneſt done. Wherefore ſuch as would paint in miniature ought to uſe it, and to inure themſelves from the firſt to dot in the plump and the ſoft way; that is to ſay, where the dots are loſt, in a manner, in the ground upon which you work, and only ſo much appears as is ſufficient to make the work ſeem dotted. The hard and the dry way is quite the reverſe, and always to be avoided. This is done by dotting with a colour much darker than your ground, and when the pencil is not moiſtened enough with the colour, which makes the work ſeem rough and uneven.

Study likewiſe carefully to loſe and drown your colours one in another, ſo that it may not appear where they disjoin; and to this end, ſoften or allay your touches with colours that partake of both, in ſuch ſort that it may not appear to be your touches which cut and disjoin them. By the word *cut*, we are to underſtand what manifeſtly ſeparates and divides, and does not run in and blend itſelf with the neighbouring colours; which is rarely practiſed but upon the borders of drapery.

When your pieces are finiſhed, to heighten them a little, gives them a fine air; that is to ſay, give, upon the extremity of the lights, ſmall touches with a colour yet lighter, which muſt be loſt and drowned with the reſt.

When the colours are dry upon your pallet or in your ſhells, in order to uſe them, they muſt be diluted with water. And when you perceive they want gum, which is ſeen when they eaſily rub off the hand or the vellum if you give a touch with them upon either, they muſt be tempered with gum-water inſtead of pure water, till they are in condition.

There are ſeveral ſorts of grounds for pictures and and portraitures. Some are wholly dark, compoſed of biſtre, umber, and Cologn earth, with a little black and white; others more yellow, in which is mixed a great deal of ochre; others greyer, which partake of indigo. In order to paint a ground, make a waſh of the colour or mixture you would have it, or according to that of the picture or portraiture you would copy; that is to ſay, a very light lay, in which there is hardly any thing but water, in order to ſoak the vellum. Then paſs another lay over that, ſomewhat thicker, and ſtrike it on very ſmoothly with large ſtrokes as quick as you can, not touching twice in the ſame place before it be dry; becauſe the ſecond ſtroke carries off what has been laid on at the firſt, eſpecially when you lean a little too hard upon the pencil.

Other dark grounds are likewiſe made of a colour a little greeniſh: and thoſe are moſt in uſe, and the propereſt to lay under all ſorts of figures and portraitures; becauſe they make the carnation, or naked parts of a picture, appear very fine; are laid on very eaſily, and there is no occaſion to dot them, as one is often obliged to do the others, which are rarely made ſmooth, and even at the firſt; whereas in theſe one ſeldom fails of ſucceſs at the firſt bout. To make them, you muſt mix black, Dutch pink, and white, all together; more or leſs of each colour, according as you would have them darker or lighter. You are to make one lay very light, and then a thicker, as of the firſt grounds. You may alſo make them of other colours, if you pleaſe; but theſe are the moſt common.

When you paint a holy perſon upon one of theſe grounds, and would paint a ſmall glory round the head of your figure, you muſt not lay the colour too thick in that part, or you may even lay none at all, eſpecially where this glory is to be very bright: but lay for the firſt time with white and a little ochre mixed together, of a ſufficient thickneſs; and in proportion as you go from the place of the head, put a little more ochre; and to make it loſe itſelf, and die away with the colour of the ground, hatch with a free ſtroke of the pencil, following the round of the glory, ſometimes with the colour of which it is made, and ſometimes with that of the ground, mixing a little white or ochre with the laſt when it paints too dark to work with: and do this till one be inſenſibly loſt in another, and nothing can be ſeen to disjoin them.

To fill an entire ground with a glory, the brighteſt part is laid on with a little ochre and white, adding more of the firſt in proportion as you come nearer the edges of the picture: and when the ochre is not ſtrong enough (for you muſt always paint darker and darker), add gall-ſtone, afterwards a little carmine, and laſtly biſtre. This firſt laying, or dead-colouring, is to be made as ſoft as poſſible; that is to ſay, let theſe ſhadowings loſe themſelves in one another without gap or interſection. Then the way is to dot upon them with the ſame colours, in order to drown the whole together; which is pretty tedious, and a little difficult, eſpecially when there are clouds of glory on the ground. Their lights muſt be fortified in proportion as you remove from the figure, and finiſhed as the reſt, by dotting and rounding the clouds; the bright and obſcure parts of which muſt run inſenſibly into one another.

For a day-ſky, take ultramarine and a good deal of white, and mix them together. With this make a lay, as ſmooth as you can, with a large pencil and liberal ſtrokes, as for grounds; applying it paler and paler as you deſcend towards the horizon; which muſt be done with vermilion or red lead, and with white of the ſame ſtrength with that where the ſky ends, or ſomething leſs; making this blue loſe itſelf in the red, which you bring down to the ſkirts of the earth, or tops of houſes; mixing towards the end gall-ſtone and a good deal of white, in ſuch a manner that the mixture be ſtill paler than the former, without any viſible interſection or parting between all theſe colours of the ſky.

When there are clouds in the ſky, you may ſpare the places where they are to be; that is to ſay, you need not lay on any blue there, but form them, if they are reddiſh, with vermilion, gall-ſtone, and white, with a little Indigo; and if they are more upon the black, put in a good deal of the laſt; painting the lights of one and the other with maſticot, vermilion, and white, more or leſs of any of theſe colours, according to

Of Draperies.

to the ſtrength you would give them, or according to that of the original you copy; rounding the whole as you dot; for it is a difficult matter to lay them very ſmooth at the firſt painting: and if the ſky is not even enough, you muſt dot it alſo.

It is at your pleaſure to exempt the places of the clouds, for you may lay them upon the ground of the ſky; heightening the bright parts by putting a good deal of white, and fortifying the ſhadows by uſing leſs. This is the ſhorteſt way.

A night or ſtormy ſky is done with indigo, black, and white, mixed together; which is laid as for a day-ſky. To this mixture muſt be added ochre, vermilion, or brown-red, for the clouds; the lights of which are to be of maſticot, or red-lead, and a little white; now redder, now yellower, at diſcretion. And when it is a tempeſtuous ſky, and lightning appears in ſome places, be it blue or red, it is to be done as in a day-ſky, drowning and loſing the whole together at the firſt forming or dead-colouring, and at the finiſhing.

Sect. IV. *Of Draperies.*

To paint a blue drapery, put ultramine near the white upon your pallet; and mix a part of the one with the other, till it makes a fine pale, and has a body. With this mixture you muſt form the brighteſt parts; and then adding more ultramarine, form ſuch as are darker; and go on after this manner till you come to the deepeſt plaits and the thickeſt ſhades, where you muſt lay pure ultramine: and all this muſt be done as for a firſt-forming or dead-colouring; that is to ſay, laying the colour on with free ſtrokes of the pencil, yet as ſmooth as you can; loſing the lights of the ſhadows with a colour neither ſo pale as the lights, nor ſo dark as the ſhades. Then dot with the ſame colour as in the firſt-forming, but a ſmall matter deeper; that the dots may be fairly ſeen. All the parts muſt be drowned one in another, and the plaits appear without interſection. When the ultramarine is not dark enough to make the deeper ſhadows, how well ſoever it be gummed, mix a little Indigo with it to finiſh them. And when the extremities of the lights are not bright enough, heighten them with white and a very little ultramarine.

A drapery of carmine is done in the ſame manner as the blue; except that in the darkeſt places there is to be a lay of pure vermilion, before you dead-colour with carmine, which muſt be applied at top; and in the ſtrongeſt ſhades, it muſt be gummed very much. To deepen it the more, mix a little biſtre with it.

There is likewiſe made another red drapery, which is firſt drawn with vermilion, mixing white with it to dead-colour the bright places; laying it pure and unmixed for thoſe that are darker, and adding carmine for the grand ſhades. It is finiſhed afterwards, like other draperies, with the ſame colours. And when the carmine with the vermilion do not darken enough, work with the firſt alone, but only in the deepeſt of the ſhades.

A drapery of lake is made in the ſame manner with that of carmine; mixing a good deal of white with it for the bright places, and very little for thoſe that are dark. It is finiſhed likewiſe with dotting; but you have nothing to do with vermilion in it.

Violet-draperies are likewiſe done after this manner; after making a mixture of carmine and ultramarine, putting always white for the bright parts. If you would have your violet be columbine or dove-colour, there muſt be more carmine than ultramarine: but if you would have it bluer and deeper, put more ultramarine than carmine.

A drapery is made of a fleſh-colour, beginning with a lay made of white, vermilion, and very pale lake; and making the ſhades with the ſame colours, uſing leſs white in them. This drapery muſt be very pale and tender, becauſe the ſtuff of this colour is thin and light; and even the ſhades of it ought not to be deep.

To make a yellow drapery, put a lay of maſticot over all; then one of gamboge upon that, excepting the brighteſt places, where the maſticot muſt be left entire; the dead-colour with ochre, mixed with a little gamboge and maſticot, putting more or leſs of the laſt according to the ſtrength of the ſhades. And when theſe colours do not darken enough, add gall-ſtone. And gall-ſtone pure and unmixed is uſed for the thickeſt ſhades; mixing a little biſtre with it, if there be occaſion to make them ſtill darker. You finiſh by dotting with the ſame colours you dead-coloured with, and loſing the lights and the ſhades in one another.

If you put Naples-yellow, or Dutch-pink, in lieu of maſticot and gamboge, you will make another ſort of yellow.

The green drapery is made by a general lay of verditer; with which, if you find it too blue, mix maſticot for the lights, and gamboge for the ſhades. Afterwards add to this mixture lily-green or ſap-green, to ſhadow with; and as the ſhades are thicker, put more of theſe laſt greens, and even work with them pure and unmixed where they are to be extremely dark. You finiſh with the ſame colours, a little darker.

By putting more yellow, or more blue, in theſe colours, you may make different ſorts of greens as you pleaſe.

To make a black drapery, you dead-colour with black and white, and finiſh with the ſame colour, putting more black, as the ſhades are thicker; and for the darkeſt, mix indigo with it, eſpecially when you would have the drapery appear like velvet. You may always give ſome touches with a brighter colour, to heighten the lights of any drapery whatſoever.

A white woolen drapery is made by a lay of white, in which there muſt be a very ſmall matter of ochre, orpiment, or gall-ſtone, that it may look a little yellowiſh. Then dead-colour, and finiſh the ſhades with blue, a little black, white, and biſtre; putting a great deal of the laſt in the darkeſt.

The light-grey is begun with black and white, and finiſhed with the ſame colour deeper.

For a brown drapery, make a lay of biſtre, white and a little brown-red; and ſhadow with this mixture, made a little darker.

There are other draperies, called *variable*, becauſe the lights are of a different colour from the ſhades. Theſe are moſtly uſed for the veſtments of angels, for young and gay people, for ſcarfs and other airy attire, admitting of a great many folds, and flowing at the

Of Draperies.

pleasure of the wind. The most common are the violets: of which they make two sorts; one, where the lights are blue; and the other, where they are yellow.

For the first, put a lay of ultramarine and very pale white upon the lights; and shadow with carmine, ultramarine, and white, as for a drapery wholly violet; so that only the grand lights appear blue. Yet they must be dotted with violet, in which there is a great deal of white, and lost insensibly in the shades.

The other is done by putting upon the lights only, instead of blue, a lay of masticot; working the rest as in the drapery all violet, excepting that it must be dotted, and the light parts blended with the shadowy, that is, the yellow with the violet, with a little gamboge.

The carmine-red is done like the last; that is, let the lights be done with masticot, and the shades with carmine; and to lose the one in the other, make use of gamboge.

The lake-red is done like that of carmine.

The green is done as the lake; always mixing verditer with lily or sap-green, to make the shades; which are not very dark.

Several other sorts of draperies may be made at discretion, always taking care to preserve the union of the colours, not only in one sort of cloth or so, but also in a group of several figures; avoiding, as much as the subject will allow, the putting of blue near the colour of fire, of green against black; and so of other colours which cut and disjoin, and whose union is not kind enough.

Several other draperies are made of foul colours, as brown-red, bistre, indigo, &c. and all in the same manner. Likewise of other colours, simple and compound; the agreement between which is always to be minded, that the mixture may produce nothing harsh and disagreable to the eye. No certain rule can be laid down for this. The force and effect of your colours are only to be known from use and experience, and you most work according to that knowledge.

Linen-cloths are done thus: After drawing the plaits or folds, as is done in a drapery, put a lay of white over all; then dead-colour, and finish the shades with a mixture of ultramarine, black, and white, using more or less of the last, according to their strength or tenderness; and in the greatest deepenings put bistre, mixed with a little white; giving only some touches of this mixture, and even of pure bistre, upon the extremities of the greatest shadows, where the folds must be drawn, and lost with the rest.

They may be done in another manner, by making a general lay of this mixture of ultramarine, black and very pale white; and dead-colour (as has been said before) with the same colour, but a little deeper. And when the shades are dotted and finished, heighten the lights with pure white, and lose them with the deepenings of the linen. But of whateve sort you make them, when they are finished, you must give a yellowish teint of orpiment and white to certain places; laying it lightly on, and as it were in water; so that what is underneath may, notwithstanding, plainly appear, as well the shadows as the dotting.

Yellow linen-cloth is done by putting a lay of white, mixed with a little ochre. Then form and finish the shades with bistre, mixed with white and ochre; and in the thickest shades use pure bistre: and before you finish, give some teints here and there of ochre and white, and others of white and ultramarine, as well upon the shades as the lights; but let them be very bright; and drown the whole together in dotting, and it will look finely. As you finish, heighten the extremities of the lights with masticot and white. You may add to this sort of linen, as well as to the white, certain bars from space to space, as in Turkey-mantuas; that is, small stripes blue and red with ultramarine and carmine; one of red between two of blue, very bright and clear upon the lights, and deeper upon the shades. Virgins are pretty often dressed with veils of this sort (by Popish painters), and scarfs of this kind are put about necks that are bare; because they become the teint mighty well.

If you would have both these sorts of linen transparent, and the stuff or other thing that is beneath appear through them, make the first lay for them very light and clear, and mix in the colour to shadow with, a little of that which is underneath, especially towards the end of the shades; and only do the extremities of the lights, for the yellow, with masticot and white; and for the white, with pure white.

They may be done in another manner, especially when you would have them altogether as clear as muslin, lawn, or gauze. To this end form and finish what is to be beneath, as if nothing was to be put over it. Then mark out the light and clear folds with white or masticot; and a shadowy with bistre and white, or with black, blue, and white, according to the colour you would make them of; making the rest somewhat fainter: yet this is not necessary but for the parts that are not to be so clear.

Crape is done the same way; excepting that the folds of the shades and the lights, and the borders too, are to be marked out with little filaments of black upon what is underneath; which is likewise to be finished beforehand.

When you would make a stuff like a watered tabby, make the waves upon it with a colour a little lighter, or a little darker, in the lights and the shades.

There is a manner of touching draperies which distinguishes the silken from the woolen. The last are more terrestrial and sensible; the others more light and fading. But it must be observed, that this is an effect which depends partly upon the stuff and partly upon the colour; and for the employing these in a manner suitable to the subjects and the deepenings of painting, we shall here touch upon their different qualities.

We have no colour which partakes more of light, nor which comes nearer the air, than white; which shews it to be fickle and fleeting. It may, nevertheless, be held and brought to by some neighbouring colour, more heavy and sensible, or by mixing them together.

Blue is a most fleeting colour: and so we see, that the sky and the remotest views of a picture are of this colour; but it will become lighter and fickler, in proportion as it is mixed with white.

Pure black is the heaviest and most terrestrial of all co-

Of Draperies.

colours; and the more of it you mix with others, the nearer you bring them to the eye.

Neverthelefs, the different difpofitions of black and white make alfo their effects different: for white often makes black difappear, and black brings white more into view; as in the reflection of globes, or other figures to be made round, where there are always parts that fly as it were from the eye, and deceive it by the craft of art: and under the white are here comprehended all the light colours; as under the black, all the heavy colours.

Ultramarine is, then, foft and light.

Ochre is not fo much fo.

Mafticot is very light; and fo is verditer.

Vermilion and carmine come near this quality.

Orpiment and gamboge not fo near.

Lake holds a certain mean, rather foft than rough.

Dutch pink is an indifferent colour, eafily taking the quality of others. So it is made terreftrial by mixing it with colours that are fo; and, on the contrary, the moft light and fleeting by joining it with white or blue.

Brown-red, umber, dark greens, and biftre, are the heavieft and moft terreftrial, next to black.

Skilful painters, who underftand perfpective, and the harmony of colours, always obferve to place the dark and fenfible colours on the fore-parts of their pictures; and the moft light and fleeting they ufe for the diftances and remote views. And as for the union of colours, the different mixtures that may be made of them will learn you the friendfhip or antipathy they have to one another. And upon this you muft take your meafures for placing them with fuch agreement as fhall pleafe the eye.

For the doing of lace, French-points, or other things of that nature, put over all a lay of blue, black, and white, as for linen: then heighten the flower-work with pure white: afterwards make the fhades above with the firft colour, and finifh them with the fame. When they are upon the carnation or naked parts of a picture, or upon any thing elfe that you would fhow through another, finifh what is beneath, as if nothing was to be put over it: and at top, make the points or lace with pure white, fhadowing and finifhing them with the other mixture.

If you would paint a fur, you muft begin with a kind of drapery, done, if it be dark, with biftre and white, making the fhadowings of the fame colour, with lefs white. If the fur be white, do it with blue, white, and a little biftre. And when this beginning, or firft-forming, is done, inftead of dotting, draw fmall ftrokes, turning, now in one manner, now in another, according to the courfe and flatting of the hair. Heighten the lights of dark furs with ochre and white, and of the other with white and a little blue.

For doing a building, if it be of ftone, take indigo, biftre, and white, with which make the beginning or firft form of it; and for fhadowing it, put lefs of this laft; and more biftre than indigo, according to the colour of the ftone you would paint. To thefe you may likewife add a little ochre, both for the forming and the finifhing. But to make it finer, you muft give, here and there, efpecially for old fabrics, blue and yellow teints, fome with ochre, others with ultramarine, mixing always white with them, whether before the firft-forming, provided they appear through the draught, or whether upon it, lofing or drowning them with the reft when you finifh.

When the building is of wood, as there are many forts, it is done at difcretion; but the moft ordinary way is to begin or firft-form with ochre, biftre, and white, and finifh without white, or with very little; and if the fhades are deep, with pure biftre. In the other they add fometimes vermilion, fometimes green or black; in a word, juft according to the colour they would give it; and they finifh with dotting, as in draperies and every thing elfe.

Of Carnations.

Sect. V. *Of Carnations, or the naked parts of Painting.*

There are in carnation fo many different colourings, that it would be a difficult thing to give general rules upon fo variable a fubject. Nor are they minded, when one has got, by cuftom and practice, fome habit of working eafily: and fuch as are arrived to this degree, employ themfelves in copying their originals, or elfe they work upon their ideas, without knowing how: infomuch, that the moft fkilful, who do it with lefs reflection and pains than others, would likewife be more put to it to give an account of their maxims and knowledge in the matter of painting, if they were to be afked what colours they made ufe of for fuch and fuch a colouring, a teint here, and another there.

Neverthelefs, as beginners want fome inftruction at the firft, we will fhow in general, after what manner feveral carnations are to be done.

In the firft place, after having drawn your figure with carmine, and ordered your piece, apply, for women and children, and generally for all tender colourings, a lay of white, mixed with a very little of the blue made for faces, of which we have told the compofition; but let it hardly be feen.

And for men, inftead of blue, they put in this firft lay a little vermilion; and when they are old, a little ochre is mixed with it.

Afterwards follow all the traces with vermilion, carmine, and white, mixed together; and begin all the fhades with this mixture, adding white in proportion as they are weaker; and putting but little in the darkeft, and none, in a manner, in certain places where ftrong touches are to be given: for inftance, in the corner of the eye; under the nofe; at the ears; under the chin; in the feparations of the fingers; in all joints; at the corners of the nails; and generally in every part where you would mark out feparations in fhades that are obfcure. Neither need you fear to give to thofe places all the force and ftrength they ought to have as foon as you begin or firft-form them, becaufe in working at top with green, the red you have put there is always weakened.

After having begun, or firft-formed, or dead-coloured, with red, make blue teints with ultramarine and a great deal of white, upon the parts which fly from the eye; that is to fay, upon the temples; under and in the corners of the eyes; on both fides the mouth, above and below; a little upon the middle of the forehead; between the nofe and the eyes; on the fide of the cheeks; on the neck and other places where

Of Carnations.

where the flesh assumes a bluish cast. Yellowish teints are likewise made with ochre or orpiment, and a little vermilion mixed with white, under the eye-brows, on the sides of the nose towards the bottom, a little underneath the cheeks, and upon the other parts which rise and come nearer the eye. It is especially from these teints that the natural complexion is to be observed, in order to catch it; for painting being an imitation of nature, the perfection of the art consists in the justness and simplicity of the representation, especially in face-painting.

When, therefore, you have done your first lay, your dead colouring, and your teints, you must work upon the shades, dotting with green for the carnations or naked parts; mixing, according to the rule we have given for the teints, a little blue for the parts which fly from the eye; and, on the other hand, making it a little yellower for those that are more sensible; that is to say, which rise, and come nearer the eye: and at the end of the shades, on the side of the light, you must blend and lose your colour insensibly in the ground of the carnation with blue, and then with red, according to the places where you paint. If this mixture of green does not work dark enough at first, pass over the shades several times, now with red, and now with green; always dotting: and this do till they are as they should be.

And if you cannot with these colours give the shades all the force they ought to have, finish, in the darkest, with bistre mixed with orpiment, ochre, or vermilion, and sometimes with pure bistre, according to the colouring you would make, but lightly, laying on your colour very clear.

You must dot upon the clear and bright places with a little vermilion or carmine, mixed with much white, and a very small matter of ochre, in order to lose them with the shadowy, and to make the teints die away insensibly into one another; taking care, as you dot, or hatch, to make your strokes follow the turnings and windings of the fleshy parts. For though the rule be to cross always, this dotting or hatching ought to appear a little more here, because it rounds the parts. And as this mixture might make a colouring too red, if it was always to be used, they work likewise in every part, to blend the teints and the shades, with blue and a little green, and much white, so mixed as to be very pale; excepting, nevertheless, that this colour must not be put upon the cheeks, nor upon the extremities of the clear parts, no more than the other mixture upon these last, which must be left with all their light; as certain places of the chin, of the nose, and of the forehead, and upon the cheeks; which, and the cheeks, ought nevertheless to be redder than the rest, as well as the feet, the hollows of the hands, and the fingers of both.

Observe, that these two last mixtures ought to be so pale, that the work shall hardly be visible; for they serve only to soften it; to unite the teints with one another, and the shades with the lights, and to drown the traces. Care must likewise be taken that you work not too much with the red mixture upon the blue teints, nor with the blue upon the others; but change the colour from time to time, when you perceive it works too blue or too red, till the work be finished.

The white of the eyes must be shadowed with this same blue, and a little flesh-colour; and the corners, on the side of the nose, with vermilion and white; giving them a little touch of carmine. The whole is softened with this mixture of vermilion, carmine, white, and a very small matter of ochre.

The apples or balls of the eyes are done with the mixture of ultramarine and white; the last prevailing a little; adding a little bistre, if they are yellowish; or a little black, if they are grey. Make the little black circle in the middle, called the *crystal of the eye;* and shadow the balls with indigo, bistre, or black, according to the colour they are of; giving to each a small touch of pure vermilion round the crystal; which must be lost with the rest at the finishing. This gives vivacity to the eye.

The round or circumference of the eye is done with bistre and carmine; that is to say, the slits or partings, and the eye-lids, when they are large and bold; especially the upper ones; which must afterwards be softened with the red or blue mixtures we have mentioned before, to the end they may be lost in one another, and nothing seem interfected. When this is done, give a little touch of pure white upon the crystal, on the side of the lights. This makes the eye shine, and gives life to it.

The mouth is dead-coloured with vermilion, mixed with white; and finished with carmine, which is softened as the rest. And when the carmine does not work dark enough, mix a little bistre with it. This is to be understood of the corners in the separation in the lips; and particularly, of certain mouths half open.

The hands, and all the other parts of carnation, are done in the same manner as the faces; observing, that the ends of the fingers be a little redder than the rest. When your whole work is formed and dotted, mark the separations of all the parts with little touches of carmine and orpiment mixed together, as well in the shadowy as the light places; but a little deeper and stronger in the first; and lose them in the rest of the carnation.

The eye-brows and the beard are dead-coloured, as are the shades of carnations; and finished with bistre, ochre, or black, according to the colour they are of, drawing them by little strokes the way they ought to go; that is to say, give them all the nature of hair. The lights of them must be heightened with ochre and bistre, a little vermilion, and much white.

For the hair of the head, make a lay of bistre, ochre, and white, and a little vermilion. When it is very dark-coloured, use black instead of ochre. Afterwards form the shadowy parts with the same colours, putting less white in them; and finish with pure bistre, or mixed with ochre or black, by small strokes very fine, and close to each other, waving and buckling them according to the curling of the hair. The light parts must also be heightened by little strokes with ochre or orpiment, white, and a little vermilion. After which, lose the lights and the shades in each other, by working sometimes with a dark, and sometimes with a pale colour.

And for the hair about the forehead, thro' which the skin is seen, it must be first formed with the colour thereof, and that of the carnation, working and shadowing with one and the other, as if you designed

to

Of Carnations.

to paint none. Then form it, and finish with bistre. The lights are to be heightened as the other. Grey hair is dead-coloured with white, black, and bistre, and finished with the same colour, but deeper; heightening the bright and clear parts of the hair, as well as those of the eye-brows and the beard, with white and very pale blue, after having formed them as the others, with the colour of the flesh or skin; and finish with bistre.

But the most important thing is to soften one's work; to blend the teints in one another, as well as the beard and the hair about the forehead, with the other hair and the carnation; taking especial care not to work rough and dry; and that the traces, turnings and windings of the carnation, or naked parts, be not interfected. You must likewise accustom yourself to put white in your colours only in proportion as you work lighter or darker: for the colour you use the second time must be always a little stronger and deeper than the first, unless it be for softening.

Different colourings are easily made, by putting more or less of red, or blue, or yellow, or bistre, whether for the dead-colouring, or for the finishing. That for women ought to be bluish; that for children a little red; and both fresh and florid. That for men ought to be yellower; especially when they are old.

To make a colouring of death, there must be a first lay of white and orpiment, or a very pale ochre: dead-colour with vermilion, and lake, instead of carmine, and a good deal of white; and afterwards work over it with a green mixture, in which there is more blue than any other colour, to the end the flesh may be livid and of a purple colour. The teints are done the same way as in another colouring; but there must be a great many more blue than yellow ones, especially upon the parts which fly from the sight, and about the eyes; and the last are only to be upon the parts which rise, and come nearer the eye. They are made to die away in one another, according to the ordinary manner; sometimes with very pale blue, and sometimes with ochre and white, and a little vermilion; softening the whole together. The parts and contours must be rounded with the same colours. The mouth is to be, in a manner, of a quite violet. It is dead-coloured, however, with a little vermilion, ochre, and white; but finished with lake and blue: and to give it the deep strokes, they take bistre and lake; with which they likewise do the same to the eyes, the nose, and the ears. If it is a crucifix, or some martyr, upon whom blood is to be seen, after the finishing the carnation, form it with vermilion, and finish it with carmine, making in the drops of blood a little bright reflecting spark, to round them. For the crown of thorns, make a lay of sea-green and masticot; shadow it with bistre and green; and heighten the clear and light parts with masticot.

Iron is formed, or first laid, with indigo, a little black and white; and finished with pure indigo, heightening it with white.

For painting fire and flames, the lights are done with masticot and orpiment; and for the shades, they mix vermilion and carmine.

A smoke is done with black, indigo and white, and sometimes with bistre: one may likewise add vermilion or ochre, according to the colour it is to be of.

Pearls are painted by putting a lay of white, and a little blue: they are shadowed and rounded with the same colour, deeper: a small white dot is made almost in the middle, on the side of the light; and on the other side, between the shadow and the edge of the pearl, they give a touch with masticot, to make the reflection; and under the pearls is made a little shadow of the colour of the ground they are upon.

Diamonds are done with pure black; then they heighten them with little touches of white on the side of the light. It is the same thing for any other jewels you have a mind to paint: there is nothing to be done but to change the colour.

For making a figure of gold, put a lay of shell-gold, and shadow it with gall-stone. Silver is done the same way; excepting that it must be shadowed with indigo.

One great means to acquire a perfection in the art, is to copy excellent originals. We enjoy with pleasure and tranquillity the labour and pains of others. But a man must copy a great number before he is able to produce as fine effects; and it is better to be a good copier than a bad author.

Of Landscapes.

Sect. VI. *Of Landscapes.*

In the first first place, after having ordered the œconomy of your landscape as of your other pieces, you must form the nearest grounds or lands, when they are to appear dark, with sap or lily-green, bistre, and a little verditer, to give a body to your colour; then dot with this mixture, but a little darker, adding sometimes a little black to it.

For such pieces of ground as the light falls upon, and which are therefore clear and bright, make a lay of ochre and white: then shadow and finish with bistre. In some they mix a little green, particularly for shadowing and finishing.

There are sometimes upon the fore-part certain reddish lands; which are dead-coloured with brown-red, white, and a little green; and finished with the same, putting a little more green in them.

For the making of grass and leaves upon the fore-ground, you must, when that is finished, form with sea-green, or verditer, and a little white; and for those that are yellowish, mix masticot. Afterwards shadow them with lily-green, or bistre and gall-stone, if you would have them appear withered.

The grounds or lands at a little distance, are formed with verditer, and shadowed and finished with sap-green, adding bistre for some of the touches here and there.

Such as are at a greater distance, are done with sea-green and a little blue; and shadowed with verditer.

In a word, the farther they go, the more blueish they are to be made; and the farthest distances ought to be of ultramarine and white; mixing in some places small touches of vermilion.

Water is painted with indigo and white, and shadowed with the same colour, but deeper: and to finish it, instead of dotting, they do nothing but make strokes and traces without crossing; giving them the same turn with the waves, when there are any. Sometimes a little green must be mixed in certain places, and

Of Landscapes.

and the light and clear parts heightened with pure white, particularly where the water foams.

Rocks are dead-coloured like buildings of ftone; excepting that a little green is mixed for forming and fhadowing them. Blue and yellow teints are made upon them, and loft with the reft in finifhing. And when there are fmall branches, with leaves, mofs, or grafs, when all is finifhed, they are to be raifed at top with green and mafticot. They may be made yellow, green, and reddifh, for appearing dry, in the fame manner as on the ground. Rocks are dotted as the reft; and the farther they are off, the more greyifh they are made.

Caftles, old houfes, and other buildings of ftone and wood, are done in the manner abovementioned; fpeaking of thofe things, when they are upon the firft lines. But when you would have them appear at a diftance, you muft mix brown-red and vermilion, with much white; and fhadow very tenderly with this mixture; and the farther they are off, the weaker are the ftrokes to be for the feparations. If they are covered with flate, it is to be made bluer than the reft.

Trees are not done till the fky be finifhed; one may, neverthelefs, fpare the places of them when they contain a good number: and however it be, fuch as come near the eye, are to be dead-coloured with verditer, mixing fometimes ochre; and fhadowed with the fame colours, adding, lily-green. Afterwards you muft work leaves upon them by dotting without croffing: for this muft be done with fmall longifh dots, of a darker colour, and pretty full of it, which muft be conducted on the fide the branches go, by little tufts of a little darker colour. Then heighten the lights with verditer or fea-green, and mafticot, making leaves in the fame manner: and when there are dry branches or leaves, they are dead-coloured with brown-red or gall-ftone, with white; and finifhed with gall-ftone, without white, or with biftre.

The trunks of trees are to be dead-coloured with ochre, white, and a little green, for the light and clear parts; and for the dark, they mix black, adding biftre and green for fhadowing one and the other. Blue and yellow teints are likewife made upon them, and little touches given here and there with white and mafticot; fuch as you ordinarily fee upon the bark of trees.

The branches which appear among the leaves are done with ochre, verditer, and white; or with biftre and white, according to the light they are placed in. They muft be fhadowed with biftre and lily-green.

Trees, which are at a little diftance, are dead-coloured with verditer and fea-green; and are fhadowed and finifhed with the fame colours, mixed with lily-green. When there are fome which appear yellowifh, lay with ochre and white, and finifh with gall-ftone.

For fuch as are in the diftances and remote views, you muft dead-colour with fea-green; with which, for finifhing, you muft mix ultramarine. Heighten the lights of one and the other with mafticot, by fmall disjoined leaves.

It is the moft difficult part of landfcape, in manner of miniature, to leaf a tree well. To learn, and break one's hand to it a little, the way is to copy good ones; for the manner of touching them is fingular, and cannot be acquired but by working upon trees themfelves; about which you muft obferve to make little boughs, which muft be leafed, efpecially fuch as are below and towards the fky.

And generally, let your landfcapes be coloured in a handfome manner, and full of nature and truth; for it is that which gives them all their beauty.

Of Flowers.

Sect. VII. *Of Flowers.*

It is an agreeable thing to paint flowers, not only on account of the fplendour of their different colours, but alfo by reafon of the little time and pains that are beftowed in trimming them. There is nothing but delight in it; and, in a manner, no application. You maim and bungle a face, if you make one eye higher than another; a fmall nofe with a large mouth; and fo of other parts. But the fears of thefe difproportions conftrain not the mind at all in flower-painting; for unlefs they be very remarkable, they fpoil nothing. For this reafon moft perfons of quality, who divert themfelves with painting, keep to flowers. Neverthelefs, you muft apply yourfelf to copy juftly: and for this part of miniature, as for the reft, we refer you to nature, for fhe is your beft model. Work, then, after natural flowers; and look for the teints and different colours of them upon your pallet: a little ufe will make you find them eafily; and to facilitate this to you at the firft, we fhall, in the continuance of our defign, fhew the manner of painting fome; for natural flowers are not always to be had; and one is often obliged to work after prints, where nothing is feen but graving.

It is a general rule, that flowers are defigned and laid like other figures; but the manner of forming and finifhing them is different: for they are firft formed only by large ftrokes and traces, which you muft turn at the firft the way the fmall ones are to go, with which you finifh; this turning aiding much thereto. And for finifhing them, inftead of hatching or dotting, you draw fmall ftrokes very fine, and very clofe to one another, without croffing; repaffing feveral times, till your dark and your clear parts have all the force you would give them.

Of Roses.—After making your firft fketch, draw with carmine the red rofe, and apply a very pale lay of carmine and white. Then form the fhades with the fame colour, putting lefs white in it: and laftly, with pure carmine, but very bright and clear at the firft; fortifying it more and more as you proceed in your work, and according to the darknefs of the fhades. This is done by large ftrokes. Then finifh; working upon it with the fame colour by little ftrokes, which you muft make go the fame way with thofe of the graving, if it be a print you copy; or the way the leaves of the rofe turn, if you copy after a painting, or after nature; lofing the dark in the clear parts, and heightening the greateft lights, and the brighteft or moft lightfome leaves, with white and a little carmine. You muft always make the hearts of rofes, and the fide of the fhadow darker than the reft; and mix a little indigo for fhadowing the firft leaves, particularly when the rofes are blown, to make them feem faded. The feed is dead-coloured with gamboge; with which a little fap-green is mixed for fhadowing. Rofes ftreaked with feveral colours, ought to be paler than

Of Flowers.

than others, that the mixture of colours may be better feen; which are done with carmine; a little darker in the fhades, and very clear in the lights; always hatching by ftrokes. For white rofes you muft put a lay of white, and form and finifh them as the red; but with black, white, and a little biftre; and make the feed a little yellower. Yellow rofes are done by putting in every part a lay of mafticot, and fhadowing them with gamboge, gall-ftone, and biftre; heightening the clear and light places with mafticot and white.

The ftiles, the leaves, and the buds of all forts of rofes are formed with verditer, with which is mixed a little mafticot and gamboge; and for fhadowing them, they add fap-green, putting lefs of the other colours when the fhades are deep. The outfide of the leaves ought to be bluer than the infide: wherefore it muft be dead-coloured with fea-green, and fap-green mixed with that for fhadowing, making the veins or fibres on this fide clearer than the ground, and thofe on the other fide darker. The prickles which are upon the ftiles and buds of rofes, are done with little touches of carmine, which are made to go every way; and for thofe that are upon the ftalks, they are formed with verditer and carmine, and fhadowed with carmine and biftre; making the bottom of the ftalks more reddifh than the top; *i. e.* you muft mix with the green, carmine and pure biftre.

Of Tulips.—As there is an infinity of tulips, different from one another, one cannot pretend to mention the colours with which they are all done. We will only touch upon the handfomeft, called *ftreaked:* and thefe ftreaks are dead-coloured, with very clear carmine in fome places, and with darker in others; finifhing with the fame colour by little ftrokes, which muft be carried the fame way with the ftreaks. And in others is put firft a lay of vermilion. Then they form them by mixing carmine, and finifh them with pure carmine. In fome they put Florence-lake over the vermilion inftead of carmine. Some are done with lake and carmine mixed together, and with lake alone, or with white and lake for the firft forming; whether it be rofe-pink or Florence-lake. There are fome of a purple colour, which are formed with ultramarine, carmine, or lake, fometimes bluer and fometimes redder. The manner of doing both one and the other is the fame: there is no difference but in the colours. You muft, in certain places, as between the ftreaks of vermilion, carmine, or lake, fometimes put blue made of ultramarine and white, and fometimes a very bright purple, which is finifhed by ftrokes as the reft, and loft with the ftreaks. There are fome likewife that have fallow teints, that are made with lake, biftre, and ochre, according as they are: but this is only in fine and rare tulips, and not in the common ones. For fhadowing the bottom of them, they ordinarily take indigo and white for fuch whofe ftreaks are of carmine. For fuch as are of lake, they take black and white; with which, in fome, biftre is mixed, and in others green. Some are likewife to be fhadowed with gamboge and umber, and always by ftrokes and traces, that turn as the leaves turn. Other tulips are likewife done, called *bordered;* that is to fay, the tulip is not ftreaked but on the edges of the leaves, where there is a border. It is white in the purple; red in the yellow; yellow in the red; and red in the white. The purple is laid with ultramarine, carmine, and white; fhadowing and finifhing it with this mixture. The border is fpared; that is to fay, let only a light lay of white be put there, and let it be fhadowed with very bright indigo. The yellow is formed with gamboge, and fhadowed with the fame colour, mixing ochre and umber or biftre with it. The border is laid with vermilion, and finifhed with a very fmall matter of carmine. The red is formed with vermilion, and finifhed with the fame colour, mixing carmine or lake with it. The bottom and the border are done with gamboge; and for finifhing, they add gall-ftone and umber, or biftre. The white is fhadowed with black, blue, and white. Indian ink is very proper for this. The fhadowings of it are very tender. It produces alone the effect of blue and white, mixed with the other black. The border of this white tulip is done with carmine. In all thefe forts of tulips, they leave a nerve or finew in the middle of the leaves that are brighter than the reft: and the borders are drowned at the bottom by fmall traces, turning croffwife; for they muft not appear cut and feparated, as the ftreaked or party-coloured. They make them likewife of feveral other colours.—When they happen to be fuch whofe bottoms on the infide are black, as it were, they form and finifh them with indigo, as alfo the feed about the nozzle or ftalk. And if the bottom is yellow, it is formed with gamboge, and finifhed by adding umbre or biftre. The leaves and the ftalks of tulips are ordinarily formed with fea-green, and fhadowed and finifhed with lily-green, by large traces all along the leaves. Some may likewife be done with verditer, mixing mafticot with it, and fhadowed with fap-green, that the green of the fhades may be yellower.

The Anemony, or *Wind-flower.*—There are feveral forts of them, as well double as fingle. The laft are ordinarily without ftreaks. Some are made of a purple colour, with purple and white, fhadowing them with the fame colour; fome redder, others bluer; fometimes very pale, and fometimes very dark. Others are formed with lake and white, and finifhed with the fame, putting lefs white; fome without any white at all. Others are formed with vermilion, and fhadowed with the fame colour, adding carmine. We fee likewife white ones, and fome of a citron colour. The laft are laid with mafticot; and one and the other fhadowed and finifhed fometimes with vermilion, and fometimes with very brown lake, efpecially near the feed, at the bottom; which is often likewife of a blackifh colour, that is done with indigo, or black and blue, mixing for fome a little biftre; and always working by very fine ftrokes and traces, and lofing the lights in the fhades. There are others that are brighter and clearer at the bottom than any where elfe; and fometimes they are perfectly white there, though the reft of the flower be dark. The feed of all thefe anemonies is done with indigo and black, with a very little white, and fhadowed with indigo; and in fome it is raifed with mafticot. The double anemonies are of feveral colours. The handfomeft have their large leaves ftreaked. Some are done, that is, the ftreaked or party-coloured, with vermilion, to which carmine is added for the finifhing; fhadowing the reft of the leaves with indigo; and for the fmall leaves

Of Flowers.

leaves within, a lay is put of vermilion and white, and they are ſhadowed with vermilion mixed with carmine, mixing here and there ſome ſtronger touches, eſpecially in the heart of the flower, next the great leaves on the ſide of the ſhadow. They finiſh with carmine, by little ſtrokes and traces, turning the ſame way with the mixed or party-colours, and the leaves. They form and finiſh the ſtreaks or party-colours of ſome others, as well as the ſmall leaves, with pure carmine; leaving, nevertheleſs, in the middle of the laſt, a little circle, in which is laid dark purple, which is loſt with the reſt. And when all is finiſhed, they give ſome touches with this ſame colour round about the ſmall leaves, eſpecially on the ſide of the ſhadow; drowning them with the large ones, the remainder of which is ſhadowed either with indigo or black. In ſome, the ſmall leaves are done with lake or purple, though the party-colours of the large ones be done with carmine. There are others, whoſe mixed colours are done with carmine, in the middle of moſt of the large leaves; putting in ſome places vermilion underneath, and loſing theſe colours with the ſhadows of the bottom; which are done with indigo and white. The ſmall leaves are laid with maſticot, and ſhadowed with very dark carmine on the ſide of the ſhade, and with very clear on the ſide of the light, leaving there in a manner pure maſticot, and giving only ſome little touches with orpiment and carmine, to ſeparate the leaves, which may be ſhadowed ſometimes with a very little pale-green. There are double anemonies painted all red, and all purple. The firſt are formed with vermilion and carmine, in a manner without white, and ſhadowed with pure carmine, well gummed, that they may be very dark. Purple anemonies are laid with purple and white, and finiſhed with white. In a word, there are double anemonies, as there are ſingle ones, of all colours; and they are done in the ſame manner. The green of one and the other is verditer; with which maſticot is mixed for forming. It is ſhadowed and finiſhed with ſap-green. The ſtiles of them are a little reddiſh; wherefore they are ſhadowed with carmine mixed with biſtre, and ſometimes with green, after having laid them with maſticot.

The Carnation and the Pink.—It is with pinks and carnations as with anemonies and tulips; that is, there are ſome mixt-coloured, and others of one ſingle colour. The firſt are ſtreaked and diverſified ſometimes with vermilion and carmine, ſometimes with pure lake, or with white; ſome ſtreaks very dark, and others very pale; ſometimes by little ſtreaks and diverſifications, and ſometimes by large ones. Their bottoms are ordinarily ſhadowed with indigo and white. There are pinks of a very pale fleſh-colour, and ſtreaked and diverſified with another, a little deeper, made with vermilion and lake. Others, which are of lake and white, are ſhadowed and ſtreaked without white. Others all red, which are done with vermilion and carmine, as dark as poſſible. Others all of lake. And laſtly, there are others, wherein nature or fancy is the rule. The green of one and the other is ſea-green, ſhadowed with lily-green or ſap-green.

The Red-lily.—It is laid with red-lead, formed with vermilion, and in the deepeſt of the ſhades with carmine; and finiſhed with the ſame colour by ſtrokes and traces, turning as the leaves turn. The clear and light parts are heightened with red-lead and white. The ſeed is done with vermilion and carmine. The green parts are done with verditer, ſhadowed with lily or ſap-green.

The Day-lily.—There are three ſorts of them:

1. The gridelin, a little red;
2. The gridelin, very pale; and,
3. The white.

For the firſt they put a lay of lake and white, and ſhadow and finiſh with the ſame colour deeper; mixing a little black to deaden it, eſpecially in the darkeſt places.

The ſecond are laid with white, mixed with a very little lake and vermilion, in ſuch a manner that theſe two laſt colours are hardly ſeen. Afterwards they ſhadow with black and a little lake, working redder in the middle of the leaves, next the ſtalks; which ought to be, as alſo the ſeed, of the ſame colour, particularly towards the top; and at the bottom a little greener.

The ſtile of the ſeed is laid with maſticot, and ſhadowed with ſap-green.

The other day-lilies are done by putting a lay of pure white, and ſhadowing and finiſhing with black and white.

The ſtalks of theſe laſt, and the greens of them all, are done with ſea-green, and ſhadowed with ſap-green.

The Hyacinth, or *Purple-flower*.—There are four ſorts of them.

The blue, a little dark;
Others paler;
The gridelin;
And the white.

The firſt are laid with ultramarine and white; and ſhadowed and finiſhed with leſs white. Others are laid and ſhadowed with pale blue. The gridelines are formed with lake and white, and a very ſmall matter of ultramarine; and finiſhed with the ſame colour a little deeper. For the laſt they put a lay of white; then they ſhadow them with black, with a little white; and finiſh them all by ſtrokes and traces, following the turnings and windings of the leaves. The green and the ſtalks of ſuch as are blue, are done with ſea and lily-green very dark: and in the ſtalks of the firſt may be mixed a little carmine, to make them reddiſh. The ſtalks of the two others, as alſo the green, are formed with verditer and maſticot, and ſhadowed with ſap-green.

The Piony.—A lay of Venice-lake and white muſt be put on all parts, pretty ſtrong: then ſhadow with leſs white, and with none at all in the darkeſt places: after which finiſh with the ſame colour by traces, turning them as for the roſe; gumming it very much in the deepeſt of the ſhades; and raiſing the lights and the edges of the moſt lightſome leaves with white and a little lake. Little veins are likewiſe made, which go like the ſtrokes in hatching, but are more viſible. The green of this flower is done with ſea-green, and ſhadowed with ſap-green.

Cowslips.—They are of four or five colours. There are ſome of a very pale purple.

The gridelin. The white and the yellow.

The purple is done with ultramarine, carmine, and white;

Of Flowers.

white; putting lefs white for fhadowing. The gridelin is laid with Venice-lake, and a very fmall matter of ultramarine, with much white; and fhadowed with the fame colour deeper. For the white, a lay of white muft be put; and they muft be fhadowed with black and white; and finifhed, as the others, by traces, or ftrokes. The heart of thefe cowflips is done with mafticot in the fhape of a ftar, which is fhadowed with gamboge, making a little circle in the middle with fap-green. The yellow are laid with mafticot, and fhadowed with gamboge and umber. The ftiles, the leaves, and the buds, are formed with verditer, mixed with a little mafticot, and finifhed with fap-green; making the fibres or veins, which appear upon the leaves, with this fame colour; and heightening the lights of the largeft with mafticot.

The Ranunculus, or *Crow-foot*.—There are feveral forts of them: the fineft are the orange-coloured. For the firft, they put a lay of vermilion, with a very fmall matter of gamboge; and add carmine for fhadowing; finifhing it with this laft colour, and a little gall-ftone. In the others may be put Venice-lake, inftead of carmine, efpecially in the heart of the flower. The orange-coloured are laid with gamboge, and finifhed with gall-ftone, vermilion, and a little carmine; leaving fome little yellow ftreaks. The green of the ftalks is done with verditer and very pale mafticot; mixing lily-green to fhadow them. That of the leaves is a little darker.

The Crocus.—Thefe are of two colours.

Yellow and purple. The yellow are formed with mafticot and gall-ftone, and fhadowed with gamboge and gall-ftone: after which, upon each leaf, on the outfide, are made three ftreaks, feparate from one another, with biftre and pure lake; which are loft, by little traces, in the bottom. The outfide of the leaves is left all yellow.—The purple are laid with carmine, mixed with a little ultramarine, and very pale white. They are formed and finifbed with lefs white; making likewife, in fome, purple ftripes or ftreaks, very dark, as in the yellow; and in others, only fmall veins. The feed of both is yellow; and is done with orpiment and gall-ftone. For the ftiles, they put a lay of white, and fhadow with black, mixed with a little green. The green of this flower is formed with very pale verditer, and fhadowed with fap-green.

The Iris.—The Perfian iris is done by putting, for the infide-leaves, a lay of white, and fhadowing them with indigo and green together, leaving a little white feparation in the middle of each leaf; and for thofe on the outfide, they put in the fame place a lay of mafticot, which is fhadowed with gall-ftone and orpiment; making little dark and longifh dots over all the leaf, at a fmall diftance from one another. And at the end of each are made large ftrains, with biftre and lake in fome, and in others with pure indigo, but very black. The reft, and the outfide of the leaves, are fhadowed with black. The green is formed with fea-green, and very pale mafticot, and fhadowed with fap-green. The Sufian iris is laid with purple and white, putting a little more carmine than ultramarine; and for the fhades, efpecially in the middle leaves, they put lefs white; and, on the contrary, more ultramarine than carmine; making the veins of this very colour, and leaving in the middle of the infide leaves a little yellow finew. There are others which have this very finew in the firft leaves; the end of which only is bluer than the reft. Others are fhadowed and finifhed with the fame purple, redder: They have alfo the middle finew on the outfide-leaves; but white and fhadowed with indigo. There are likewife yellow ones; which are done by putting a lay of mafticot and orpiment; fhadowing them with gall-ftone, and making the veins upon the leaves with biftre. The green of one and the other is done with fea-green, mixing a little mafticot for the ftiles. They are fhadowed with fap-green.

The Jasmin.—It is done with a lay of white, and fhadowed with black and white; and for the outfide of the leaves, they mix a little biftre; making the half of each, on this fide, a little reddifh with carmine.

The Tuberose.—For the doing of this, they make a lay of white, and fhadow with black, with a little biftre in fome places; and for the outfide of the leaves, they mix a little carmine, to give them a reddifh teint, particularly upon the extremities. The feed is done with mafticot, and fhadowed with fap-green. The green of it is laid with verditer, and fhadowed with fap-green.

The Hellebore.—The flower of hellebore is done almoft in the fame manner; that is, let it be laid with white, and fhadowed with black and biftre, making the outfide of the leaves a little reddifh here and there. The feed is laid with dark green, and raifed with mafticot. The green of it is foul and rufty, and is formed with verditer, mafticot, and biftre; and finifhed with fap-green and biftre.

The White lily.—It is laid with white, and fhadowed with black and white. The feed is done with orpiment and gall-ftone. And the green is done as in the tuberofe.

The Snow-drop.—It is formed and finifhed as the white lily. The feed is laid with mafticot, and fhadowed with gall-ftone. And the green is done with fea and fap-green.

The Jonquil.—It is laid with mafticot and gall-ftone, and finifhed with gamboge and gall-ftone. The green is formed with fea-green, and fhadowed with fap-green.

The Daffodil.—All daffodils, the yellow, the double, and the fingle, are done by putting a lay of mafticot: they are formed with gamboge, and finifhed by adding umber and biftre; excepting the bell in the middle, which is done with orpiment and gall-ftone, bordered or edged with vermilion and carmine. The white are laid with white, and fhadowed with black and white; excepting the cup or bell, which is done with mafticot and gamboge. The green is fea-green, fhadowed with fap-green.

The Marigold.—It is done by putting a lay of mafticot, and then one of gamboge; fhadowing it with this very colour, after vermilion is mixed with it: and for finifhing, they add gall-ftone and a little carmine. The green is done with verditer, fhadowed with fap-green.

The Austrian Rose.—For making the Indian rofe, they put a lay of mafticot, and another of gamboge. Then they form it, mixing gall-ftone; and finifh it with the laft colour, adding biftre and a very fmall

Of Flowers.

small matter of carmine in the deepest shades.

The Indian Pink, or *French Marigold*.—It is done by putting a lay of gamboge; shadowing it with this colour, after you have mixed a good deal of carmine and gall-stone with it; and leaving about the leaves a little yellow border of gamboge, very clear in the lights, and darker in the shades. The seed is shadowed with bistre. The green as well of the rose as the pink, is formed with verditer, and finished with sap-green.

The Sun-flower.—It is formed with masticot and gamboge, and finished with gall-stone and bistre. The green is laid with verditer and masticot, and shadowed with sap-green.

The Passion-flower.—It is done as the rose, and the green of the leaves likewise; but the veins are done with a darker green.

Poetical pinks and Sweet-williams—They are done by putting a lay of lake and white; shadowing them with pure lake, with a little carmine for the last; which are afterwards dotted on all parts with little round dots, separate from one another; and the threads in the middle are raised with white. The green of them are sea-green, which is finished with sap-green.

The Scabious.—There are two sorts of scabious, the red and the purple. The leaves of the first are laid with Florence-lake, in which there is a little white; and shadowed without white: and for the middle, which is a great boss or husk in which the seed lies, it is formed and finished with pure lake, with a little ultramarine or indigo to make it darker. Then they make little white longish dots over it, at a pretty distance from one another, clearer in the light than in the shade, making them go every way. The other is done by putting a lay of very pale purple, as well upon the leaves as the boss in the middle; shadowing both with the same colour, a little deeper: and instead of little white touches from the seed, they make them purple; and about each grain they make out a little circle, and this over the whole boss or husk in the middle. The green is formed with verditer and masticot, and shadowed with sap-green.

The Sword or *Day-lily*.—It is laid with Florence-lake and very pale white; formed and finished with pure lake, very clear and bright in some places, and very dark in others; mixing even bistre in the thickest of the shades. The green is verditer, shadowed with sap-green.

Hepatica, or *Liverwort*.—There is red and blue. The last is done by putting on all parts a lay of ultramarine, white, and a little carmine or lake; shadowing the inside of the leaves with this mixture, but deeper; excepting those of the first rank; for which, and for the outside of every one of them, they add indigo and white, that the colour may be paler, and not so fine. The red is laid with lake-columbine and very pale white; and finished with less white. The green is done with verditer, masticot, and a little bistre; and shadowed with sap-green, and a little bistre, especially on the outside of the leaves.

The Pomegranate.—The flower of the pomegranate is laid with red-lead; shadowed with vermilion and carmine; and finished with this last colour. The green is laid with verditer and masticot, and shadowed with sap-green.

The Flower of the Indian Bean.—It is done with a lay of Levant-lake and white; shadowing the middle leaves with pure lake; and adding a little ultramarine for the others. The green is verditer, shadowed with sap-green.

The Columbine.—There are columbines of several colours: the most common are the purple, the gridelin, and the red. For the purple, they lay with ultramarine, carmine, and white; and shadow with this mixture, deeper. The gridelin are done the same way, putting a great deal less ultramarine than carmine. The red are done with lake and white, finishing with less white. There are some mixed flowers of this kind, of several colours; which must be formed and finished as the others, but paler, making the mixtures of a little darker colour.

The Lark's Heel.—There are of different colours, and of mixed colours: the most common are the purple, the gridelin, and the red; which are done as the columbines.

Violets and Pansies.—Violets and pansies are done the same way; excepting that in the last the two middle leaves are bluer than the others, that is, the borders or edges; for the inside of them is yellow; and there little black veins are made, which take their beginning from the heart of the flower, and die away towards the middle.

The Muscipula, or *Catch-fly*.—There are two sorts of it, the white and the red; the last is laid with lake and white, with a little vermilion, and finished with pure lake. As for the knot or nozzle of the leaves, it is formed with white and a very small matter of vermilion, mixing bistre, or gall-stone, to finish it. The leaves of the white are laid with white; adding bistre and masticot upon the knots, which are shadowed with pure bistre, and the leaves with black and white. The green of all these flowers is done with verditer and masticot, and shadowed with sap-green.

The Crown Imperial.—There are of two colours, the yellow and the red. The first is done by putting a lay of orpiment, and shadowing it with gall-stone and orpiment, with a little vermilion. The other is laid with orpiment and vermilion, and shadowed with gall-stone and vermilion; making the beginning of the leaves next the stile, with lake and bistre, very dark; and veins with this mixture, both in one and the other, all along the leaves. The green is done with verditer and masticot, shadowed with sap-green and gamboge.

The Cyclamen, or *Sow-bread*.—The red is laid with carmine, a little ultramarine, and much white; and finished with the same colour, deeper; putting, in a manner, only carmine in the middle of the leaves, next the heart, and in the rest add a little more ultramarine. The other is laid with white, and shadowed with black. The stalks of one and the other ought to be a little reddish; and the green, verditer and sap-green.

The Gilliflower.—There are several sorts of gilliflowers; the white, the yellow, the purple, the red, and the mixed, of various colours. The white are laid with white, and shadowed with black, and with a little indigo in the heart of the leaves. The yellow, with masticot, gamboge, and gall-stone. The purple are formed with purple and white; and finished with less white;

Of Fruits, &c.

white; making the colour brighter in the heart, and even a little yellowish. The red with lake and white; finishing them with white. The mixed-coloured are laid with white, and the mixtures are sometimes made with purple, in which there is much ultramarine; others again, in which there is more carmine. Sometimes they are of lake, and sometimes of carmine. Some are done with white, and others without white; shadowing the rest of the leaves with indigo. The seed of all is formed with verditer and masticot, and finished with sap-green. The leaves and stiles are laid with the same green, mixing sap-green to finish them.

Fruits, fishes, serpents, and all sorts of reptiles, are to be touched in the same manner as the figures of men are; that is, hatched or dotted.

Birds and all other animals are done like flowers, by strokes, or traces.

Never make use, for any of these things, of white-lead. It is only proper in oil. It blackens like ink, when only tempered with gum; especially if you set your work in a moist place, or where perfumes are. Cerus of Venice is as fine, and of as pure a white. Be not sparing in the use of this, especially in forming or dead-colouring; and let it enter into all your mixtures, in order to give them a certain body, which will render your work glueish, and make it appear soft, plump, and strong.

The taste of painters is, nevertheless, different in this point. Some use a little of it, and others none at all. But the manner of the last is meagre and dry. Others use a great deal; and doubtless it is the best method and most followed among skilful persons: for besides that it is speedy, one may by the use of it copy all sorts of pictures; which would be almost impossible otherwise; notwithstanding the contrary opinion of some, who say, that in miniature we cannot give the force and all the different teints we see in pieces in oil. But this is not true, at least of good painters; and effects prove it pretty plainly: for we see figures, landscapes, pictures, and every thing else in miniature, touched in as grand, as true, and as noble a manner, (though more tender and delicate), as they are in oil.

Properties of Miniature.

However, painting in oil has its advantages; were they only these, that it exhibits more work, and takes up less time. It is better defended likewise against the injuries of time; and the right of birth must be granted it, and the glory of antiquity.

But miniature likewise has its advantages; and without repeating such as have been mentioned already, it is neater and more commodious. You may easily carry all your implements in your pockets, and work when and wherever you please, without such a number of preparations. You may quit and resume it when and as often as you will; which is not done in the other; in which one is rarely to work dry.

To conclude: In the art of painting, excellence does not depend upon the greatness of the subject, but upon the manner in which it is handled. Some catch the airs of a face well; others succeed better in landscapes: some work in little, who cannot do it in large: some are skilled in colours, who know little of design: others, lastly, have only a genius for flowers: and even the Bassans got themselves a fame for animals; which they touched in a very fine manner, and better than any thing else.

Minim ‖ Minium.

MINIM, in music, a note equal to two crotchets, or half a semibreve. See Music.

MINIMS, a religious order in the church of Rome, founded by St Francis de Paula, towards the end of the 15th century. Their habit is a coarse black woollen stuff, with a woollen girdle, of the same colours, tied in five knots. They are not permitted to quit their habit and girdle night nor day. Formerly they went bare-footed, but are now allowed the use of shoes.

MINIMUM, in the higher geometry, the least quantity attainable in a given case.

MINISTER, a person who preaches, performs religious worship in public, administers the sacraments, &c.

Minister *of State*, a person to whom the prince intrusts the administration of government. See Counsel.

Foreign Minister, is a person sent into a foreign country, to manage the affairs of his province, or of the state to which he belongs. Of these there are two kinds: those of the first rank are ambassadors, and envoys extraordinary, who represent the persons of their sovereigns; the ministers of the second rank are the ordinary residents.

MINIUM, or Red-lead. See Chemistry, n° 402.

The general method of preparing that colour is there described; but the following more accurate and particular one hath appeared in the last edition of the Chemical Dictionary. "The furnace in which minium is made is of the reverberatory kind, with two fire-places at the ends; each fire-place being separated from the area, or body of the furnace, by a wall 12 inches high. The fire-places are 15 inches broad, and their length is equal to the breadth of the whole furnace, which is about eight or nine feet. The length of the area from one fire-place to the other is 9 or 10 feet. The quantity of lead used in one operation is about 1500 pounds, of which nine parts are lead obtained from furnaces where the ore is smelted, and one part is lead extracted from the scoria which is formed in smelting the ore. This latter kind is said to be necessary, as the former could not alone be reduced into powder. All the lead is at once put into the area, the bottom of which is level. The calx, as fast as it is formed, is drawn to one side by means of a rake suspended by a chain before the mouth of the furnace. In four or five hours the whole quantity of the lead is calcined, or, if any pieces remain uncalcined, they are separated, and kept for the next operation. The heat employed is that of a cherry-red; and the fire-places and mouth are kept open, that the air may accelerate the calcination. The powder or calx is to be frequently stirred to prevent its concreting; and when this operation has been continued about 24 hours, the matter is taken out of the furnace, and laid on a flat pavement. The cold water is thrown on it, to give it weight, as the workmen say; but rather, as some think, to make it friable. It is then to be ground in a mill, and the finer

finer part is feparated by wafhing, while the coarfer part, referved for fome following operation, is to be placed at the mouth of the furnace in order to retain the melted lead. The fine powder, which is now of a yellow colour, is again put into the fame or a fimilar furnace, and expofed to a very moderote fire from 36 to 48 hours; during which time it is ftirred frequently to prevent its concreting; and the powder gradually acquires its proper red colour. The minium is then to be taken out of the furnace, cooled, and fifted thro' an iron fieve placed in a cafk."

MINOR, in law. See Law, n° clxi.

Minor, in logic, the fecond propofition of a regular fyllogifm. See Logic.

MINORCA, an ifland of the Mediterranean, fituated between 39 and 40 degrees of North Latitude, and near four degrees of Eaft Longitude. It is about 33 miles in length from north-weft to fouth-eaft, in breadth from eight to twelve, but in general about ten miles; fo that in fize it may nearly equal the county of Huntingdon or Bedfordfhire. The form is very irregular; and the coafts are much indented by the fea, which forms a great number of little creeks and inlets, fome of which might be very advantageous.

This ifland is one of thofe called by the ancient Romans *Baleares*, which arofe from the dexterity of the inhabitants in ufing the fling. It fell under the power of the Romans, afterwards of the northern barbarians, who deftroyed that empire. From them it was taken by the Arabs, who were fubdued by the king of Majorca, and he by the king of Spain. The Englifh fubdued it in 1708, and the French in the late war; but it was reftored to Britain by the treaty of Paris in 1763.

The air of this ifland is much more clear and pure than in Britain; being feldom darkened with thick fogs: yet the low valleys are not free from mifts and unwholefome vapours; and in windy weather the fpray of the fea is driven over the whole ifland. Hence it happens that utenfils of brafs or iron are extremely fufceptible of ruft, in fpite of all endeavours to preferve them; and houfehold furniture becomes mouldy. The fummers are dry, clear, calm, and exceffively hot; the autumns moift, warm, and unequal; at one time perfectly ferene, at another cloudy and tempeftuous. During the winter there are fometimes violent ftorms, though neither frequent nor of long continuance; and whenever they ceafe, the weather returns to its ufual ferenity. The fpring is always variable, but refembles the winter more than the fummer. The changes of heat and cold are neither fo great nor fo fudden in this climate as in many others. In the compafs of a year, the thermometer feldom rifes much above the 80th, or falls below the 48th degree. In fummer there is fcarcely ever a difference of four or five degrees between the heat of the air at noon and at night; and in winter the variation is ftill lefs confiderable. But this muft be underftood of a thermometer fhaded from the influence of the folar beams; for if expofed to them it will often rife 12, 14, or 16 degrees higher than what we have mentioned; and in other feafons the difference between the heat of the air in the fun and in the fhade is much greater. Yet, even in the dog-days, the heat of the atmofphere, at leaft in open places, feldom furpaffes that of human blood. The winds are very boifterous about the equinoxes, and fometimes during during the winter. At other times they are generally moderate, and, according to the obfervations of feamen, they rarely blow in the fame direction near the iflands adjacent to the gulph of Lyons as in the open fea. During the fummer there is commonly a perfect calm in the mornings and evenings: but the middle of the day is cooled by refrefhing breezes which come from the eaft, and, following the courfe of the fun, increafe gradually till two or three in the afternoon; after which they infenfibly die away, as night approaches. This renders the heat of the fun lefs dangerous and inconvenient; and if thefe breezes intermit for a day or two, the natives grow languid and inactive from the heat. The northerly winds in general are clear and healthy, difpel the mifts, and make a clear blue fky; whilft thofe which blow from the oppofite quarter, render the air warm, moift, and unhealthy. The north wind is fuperior in power to all the reft; which appears from hence, that the tops of all the trees incline to the fouth, and the branches on the north fide are bare and blafted. The next to it in force is the north-weft. Both are frequent towards the clofe of winter, and in the fpring; and, being dry and cold, they fhrivel up the leaves of the vegetables, deftroy their tender fhoots, and are often exceffively detrimental to the vineyards and rifing corn. The piercing blafts at that feafon from the north-eaft, as they are more moift, and more frequently attended with rain, are lefs prejudicial. The fouth and fouth-eaft winds are by much the moft unhealthy. In whatever feafons they blow, the air is foggy, and affects the breathing; but in the fummer feafon they are fultry and fuffocating. An exceffive dejection of fpirits is then a univerfal complaint; and on expofing the thermometer to the rays of the fun, the mercury has frequently rifen above the 100th degree. The weft wind is ufually drier than the fouth: the eaft is cold and bluftering in the fpring, and fultry in the fummer.

The weather in Minorca is generally fair and dry; but when it rains, the fhowers are heavy, though of fhort continuance, and they fall moft commonly in the night. The fky in fummer is clear, and of a beautiful azure, without clouds or rain; but moderate dews defcend regularly after funfet. In autumn the weather becomes lefs ferene; whirlwinds and thunder become frequent; and in the night-time lightning, and thofe meteors called *falling ftars*, are very common. Water-fpouts alfo are often feen at that feafon, and frequently break upon the fhore. A fudden alteration in the weather takes place about the autumnal equinox; the fkies are darkened with clouds, and the rains fall in fuch quantities, that the torrents thereby occafioned, pouring down from the hills, tear up trees by the root, carry away cattle, break down fences, and do confiderable mifchief to the gardens and vineyards. But thefe anniverfary rains are much more violent than lafting; always falling in fudden and heavy fhowers, with intervals of fair weather. They are accompanied with thunder, lightning, and fqualls of wind, moft commonly from the north. Hail and fnow are often intermixed with the rains which fall in winter and in fpring; but the fnow, for the moft part, diffolves immediately; and ice is here an uncom-

 mon appearance.

The whole coast of Minorca lies low; and there are only a few hills near the centre, of which the most considerable, named *Toro* by the inhabitants, may be seen at the distance of 12 or 14 leagues from the land. The surface of the island is rough and unequal; and in many places divided by long narrow vales of a considerable depth, called *barrancoes* by the natives. They begin towards the middle of the island, and after several windings terminate at the sea. The south-west side is more plain and regular towards the north-east; where the hills are higher, with low, marshy valleys betwixt them, the soil less fruitful, and the whole tract unhealthy to man and beast. Near the towns and villages the fields are well cultivated, and inclosed with stone-walls; but the rest, for the most part, are rocky, or covered with woods and thickets. There are some pools of standing water, but very few rivulets; which is the greatest defect about the island, as the inhabitants have scarcely any wholesome water excepting what is saved from the clouds.

The soil is light, thin, and very stony, with a good deal of sea-salt, and, in some places, of calcareous nitre intermixed. In most places there is so little earth, that the island appears to be but one large irregular rock covered here and there with mould, and an infinite variety of stones. Notwithstanding this, however, it is not only extremely proper for vineyards, but produces more wheat and barley than could at first sight be imagined; and, if the peasants may be credited, it would always yield a quantity of corn and wine sufficient for the natives, did not the violence of the winds, and the excessive drought of the weather, frequently spoil their crops. The fields commonly lie fallow for two years, and are sown the third. About the latter end of winter, or the beginning of spring, they are first broke up; and next autumn, as soon as the rains fall, they are again ploughed and prepared for receiving the proper seeds. The tillage is very easily performed; for a plough so light as to be transported from place to place on the ploughman's shoulder, and to be drawn by an heifer, or an ass sometimes assisted by an hog, is sufficient for opening so thin a soil. The later the harvest happens, the more plentiful it proves. The barley is usually cut down about the 20th of May N. S. and the wheat is reaped in June; so that the whole harvest is commonly got in by midsummer-day. The grain is not threshed with flails as in this country, but trodden out on a smooth piece of rock by oxen and asses, according to the custom of the eastern nations.

The natives of Minorca are commonly lean, thin, and well-built, of a middle stature, and olive complexion; but their character is by no means agreeable. Such is the natural impetuosity of their temper, that the slightest cause provokes them to anger; and they seem to be incapable of forgiving or forgetting an injury. Hence quarrels break out daily, even among neighbours and relations; and family-disputes are transmitted from father to son; and thus, though lawyers and pettifoggers are very numerous in this country, there are still too few for the clients. Both sexes are, by constitution, extremely amorous: they are often betrothed to each other while children, and marry at the age of 14. The women have easy labours, and commonly return in a few days to their usual domestic business; but, lest the family should become too numerous for their income, it is a practice among the poorer sort to keep their children at the breast for two or three years, that by this means the mothers may be hindered from breeding.

Bread of the finest wheat-flour, well fermented and well baked, is more than half the diet of people of all ranks. Rice, pulse, vermicelli, herbs and roots from the garden, summer-fruits, pickled olives, and pods of the Guinea pepper, make up almost all the other half; so that scarce a fifth of their whole food is furnished from the animal-kingdom, and of this fish makes by much the most considerable portion. On Fridays, and other fast-days, they abstain entirely from flesh; and during Lent they live altogether on vegetables and fish, excepting Sundays, when they are permitted the use of eggs, cheese, and milk. Most of their dishes are high-seasoned with pepper, cloves, cinnamon, and other spices; and garlic, onions, or leeks, are almost constant ingredients. They eat a great deal of oil, and that none of the sweetest or best flavoured; using it not only with sallads, but also with boiled and fried fish, greens, pulse, &c. instead of butter. A slice of bread soaked in boiled water, with a little oil and salt, is the common breakfast of the peasants, well known by the name of *oleagua*. Their ordinary meals are very frugal, and consist of very little variety; but on festivals and other solemn occasions, their entertainments are to the last degree profuse and extravagant, insomuch that the bill of fare of a country farmer's wedding-dinner would scarce be credited.

With regard to other matters, the Minorquins are accused of prodigious indolence in the way of business, and neglect of the natural advantages they possess. In the bowels of the earth are iron, copper, and lead-ores, of none of which any use hath been made except the last. A lead-mine was worked to advantage some time ago, and the ore sent into France and Spain for the use of the potteries in those countries. The proprietor discontinued his work on some small discouragement; and indeed it is said, that these people are of all mankind the most easily put out of conceit with an undertaking that does not bring them in mountains of present gain, or that admits of the slightest probability of disappointing their most sanguine expectations: nor will their purse admit of many disappointments; and thus their poverty co-operating with their natural despondence and love of ease, is the principal cause of their backwardness to engage in projects, though ever so promising, for the improvement of their private fortune, and the advantage of the commerce of their country. This lead-ore went under the name of *vernis* among the natives, as it was wholly used by the potters in varnishing and glazing their earthen vessels.

There are few exports of any account, and they are obliged to their neighbours for near one-third of their corn, all their oil, and such a variety of articles of less consideration, that nothing could preserve them from a total bankruptcy, but the English money circulated by the troops, which is exchanged for the daily supplies of provisions, increased by the multiplication of vineyards, the breeding of poultry, and the production of vegetables, in a proportion of

at least five to one since the island has been in our possession. It will not require many words to enumerate their exports: they make a sort of cheese, little liked by the English, which sells in Italy at a very great price; this, perhaps, to the amount of 800 l. *per annum*. The wool they send abroad may produce 900 l. more. Some wine is exported; and, if we add to its value that of the home-consumption, which has every merit of an export, being nine parts in ten taken off by the troops for ready money, it may well be estimated at 16,000 l. a-year. In honey, wax, and salt, their yearly exports may be about 400 l. and this comes pretty near the sum of their exports, which we estimate together at 18,100 l. Sterling *per annum*.

A vast balance lies against them, if we consider the variety and importance of the articles they fetch from other countries, for which they must pay ready cash. Here it may be necessary to withdraw some things from the heap, such as their cattle, sheep, and fowls, on which they get a profit; for the country does not produce them in a sufficient abundance to supply them, especially when we have a fleet of men of war stationed there.

Their imports are, corn, cattle, sheep, fowls tobacco, oil, rice, sugar, spices, hard-ware, and tools of all kinds; gold and silver lace; chocolate, or cacoa to make it; tobacco, timber, plank, boards, mill-stones, tobacco-pipes, playing cards, turnery ware, seeds, soap, saddles; all manner of cabinet-makers work, iron spikes, nails, fine earthen-ware, glass, lamps, brasiery, paper, and other stationary wares; copperas, galls, dye-stuffs, painters brushes, and colours; musical instruments, music, and strings; watches, wine, fruit, all manner of fine and printed linens, muslins, cambrics, and laces; bottles, corks, starch, indigo, fans, trinkets, toys, ribbands, tape, needles, pins, silk, mohair, lanthorns, cordage, tar, pitch, rosin, drugs, gloves, fire-arms, gunpowder, shot, and lead; hats, caps, velvet, cotton stuffs, woollen cloths, stockings, capes, medals, vestments, lustres, pictures, images, agnus Dei's, books, pardons, bulls, relics, and indulgencies.

The island is divided into what they style *terminos*, of which there were anciently five, now reduced to four, and resemble our counties. The termino of Ciudadella, at the north-western extremity of the island, is so styled from this place, which was once a city, and the capital of Minorca. It makes a venerable and majestic figure, even in its present state of decay, having in it a large Gothic cathedral, some other churches and convents, the governor's palace, and an exchange, which is no contemptible pile. There are in it 600 houses, which, before the seat of government and the courts of justice were removed to Mahon, were fully inhabited; and there are still more gentlemens families here than in all the rest of the island. It hath a port commodious enough for the vessels employed in the trade of this country, which, though in the possession of a maritime power, is less than it formerly was. It is still, in the style of our officers, *the best quarters* (and there are none bad), in the country; and if there was a civil government, and the place made a free port, the best judges are of opinion it would very soon become a flourishing place again; and the fortifications, if it should be found necessary, might then also be easily restored and improved.

The termino of Fererias is the next, a narrow slip reaching cross from sea to sea, and the country little cultivated; it is therefore united to Mercandal. In this last termino stands Mont-toro in the very centre of the isle, and the highest ground, some say the only mountain in it; on the summit of which there is a convent, where, even in the hottest months, the monks enjoy a cool air, and at all times a most delightful prospect. About six miles north from Mont-toro stands the castle that covers Port Fornelles, which is a very spacious harbour on the east side of the island. There are in it shoals and foul ground, which, to those who are unacquainted with them, render it difficult and dangerous; yet the packets bound from Mahon to Marseilles frequently take shelter therein; and while the Spaniards were in possession of the isle, large ships and men of war frequented it. At a small distance from this lies another harbour called *Adaia*, which runs far into the land; but being reputed unsafe, and being so near Fornelles, is at present useless. The country about it is, however, said to be the pleasantest and wholesomest spot in the island, and almost the only one plentifully supplied with excellent spring-water, so that the gardens are well laid out, and the richest and finest fruits grow here in the highest perfection. Alaior is the next termino, in which there is nothing remarkable but the capital of the same name, well situated on an eminence, in a pleasant and tolerably cultivated country.

The termino of Mahon, at the south-east end of the island, is at present the most considerable of them all, containing about 60,000 English acres, and nearly one-half of the inhabitants in Minorca. The town of Mahon derives its name from the Carthaginian general Mago, who is universally allowed to be its founder. It stands on an eminence on the west side of the harbour, the ascent pretty steep. There are in it a large church, three convents, the governor's palace, and some other public edifices. It is large; but the streets are winding, narrow, and ill-paved. The fortress of St Philip stands near the entrance of the harbour, which it covers, is very spacious, of great strength, with subterranean works to protect the garrison from bombs, large magazines, and whatever else is necessary to render it a complete fortification, and hath a numerous and well-disposed artillery. Port Mahon is allowed to be the finest harbour in the Mediterranean, about 90 fathoms wide at its entrance, but within very large and safe, stretching a league or more into the land. Beneath the town of Mahon there is a very fine quay, one end of which is reserved for the ships of war, and furnished with all the accommodations necessary for careening and refitting them; the other serves for merchantmen. On the other side the harbour is Cape Mola, where it is generally agreed a fortress might be constructed which would be impregnable, as the castle of St Philip was esteemed before we took it, and bestowed so much money upon it, that, though some works were erected at Cape Mola, it was not judged proper to proceed in the fortifications there at a fresh expence; at least this is the only reason that hath been assigned.

MINOS, in fabulous history, king of Crete, was

the son of Jupiter and Europa. He is said to have built several cities in the island of Crete; to have given laws to the Cretans; and to have had a son, from whom sprung Minos II. king of Crete, Sarpedon, and Rhadamanthus, who distributed justice with such severity, that they were, according to the poets, constituted judges of hell, where the most difficult cases were referred to Minos, who was distinguished from the rest by his holding a sceptre of gold.

MINOTAUR, in antiquity, a fabulous monster much talked of by the poets, feigned to be half man and half bull.

The minotaur was brought forth by Pasiphäe, wife of Minos king of Crete. It was shut up in the labyrinth of that island, and at last killed by Theseus.

Servius gives the explanation of this fable: he says that a secretary of king Minos, named *Taurus*, "bull," having an intrigue with the queen (Pasiphäe) in the chamber of Dædalus, she was at length delivered of twins; one of whom resembled Minos, and the other Taurus. This occasioned the production to be reputed monstrous.

MINOW, a very small species of cyprinus, so well known that it needs no description.

MINSTREL, an ancient term for a singer and instrumental performer.

The word *minstrel* is derived from the French *menestrier*, and was not in use here before the Norman conquest. It is remarkable, that our old monkish historians do not use the worc *citharædus*, *cantator*, or the like, to express a *minstrel* in Latin; but either *mimus*, *histrio*, *joculator*, or some other word that implies *gesture*. Hence it should seem that the minstrels set off their singing by mimicry, or action; or, according to Dr Brown's hypothesis, united the powers of melody, poem, and dance.

The Saxons, as well as the ancient Danes, had been accustomed to hold men of this profession in the highest reverence. Their skill was considered as something divine, their persons were deemed sacred, their attendance was solicited by kings, and they were every-where loaded with honours and rewards. In short, poets and their art were held among them in that rude admiration which is ever shewn by an ignorant people to such as excel them in intellectual accomplishments. When the Saxons were converted to Christianity, in proportion as letters prevailed among them, this rude admiration began to abate, and poetry was no longer a peculiar profession. The poet and the minstrel became two persons. Poetry was cultivated by men of letters indiscriminately, and many of the most popular rhymes were composed amidst the leisure and retirement of monasteries. But the minstrels continued a distinct order of men, and got their livelihood by singing verses to the harp at the houses of the great. There they were still hospitably and respectfully received, and retained many of the honours shewn to their predecessors the Bards and Scalds. And indeed, though some of them only recited the compositions of others, many of them still composed songs themselves; and all of them could probably invent a few stanzas on occasion. There is no doubt but most of the old heroic ballads were produced by this order of men. For although some of the larger metrical romances might come from the pen of the monks or others, yet the smaller narratives were probably composed by the minstrels who sung them. From the amazing variations which occur in different copies of these old pieces, it is evident they made no scruple to alter each other's productions, and the reciter added or omitted whole stanzas, according to his own fancy or convenience.

In the early ages, as is hinted above, this profession was held in great reverence among the Saxon tribes, as well as among their Danish brethren. This appears from two remarkable facts in history, which shew that the same arts of music and song were equally admired among both nations, and that the privileges and honours conferred upon the professors of them were common to both; as it is well known their customs, manners, and even language, were not in those times very dissimilar.

When king Alfred the Great was desirous to learn the true situation of the Danish army, which had invaded his realm, he assumed the dress and character of a minstrel; and taking his harp, and only one attendant, (for in the earliest times it was not unusual for a minstrel to have a servant to carry his harp), he went with the utmost security into the Danish camp. And though he could not but be known to be a Saxon, the character he had assumed procured him a hospitable reception; he was admitted to entertain the king at table, and staid among them long enough to contrive that assault which afterwards destroyed them. This was in the year 878.

About 60 years after, a Danish king made use of the same disguise to explore the camp of king Athelstan. With his harp in his hand, and dressed like a minstrel, Anlaff king of the Danes went among the Saxon tents, and taking his stand near the king's pavilion, began to play, and was immediately admitted. There he entertained Athelstan and his lords with his singing and his music; and was at length dismissed with an honourable reward, though his songs must have discovered him to have been a Dane. Athelstan was saved from the consequences of this stratagem by a soldier, who had observed Anlaff bury the money which had been given him, from some scruple of honour, or motive of superstition. This occasioned a discovery.

From the uniform procedure of both these kings, it is plain that the same mode of entertainment prevailed among both people, and that the minstrel was a privileged character among both. Even as late as the reign of Edward II. the minstrels were easily admitted into the royal presence, as appears from a passage in Stow, which also shews the splendour of their appearance.

"In the year 1316, Edward the second did solemnize his feast of Pentecost at Westminster, in the great hall: where sitting royally at the table with his peers about him, there entered a woman adorned like a minstrel, sitting on a great horse trapped, as minstrels then used, who rode round about the tables, shewing pastime; and at length came up to the king's table, and laid before him a letter, and forthwith turning her horse, saluted every one, and departed."—The subject of this letter was a remonstrance to the king on the favours heaped by him on his minions, to the

Minstrel. the neglect of his knights and faithful servants

The messenger was sent in a minstrel's habit, as what would gain an easy admission; and was a woman concealed under that habit, probably to disarm the king's resentment: for we do not find that any of the real minstrels were of the female sex; and therefore conclude this was only an artful contrivance peculiar to that occasion.

In the 4th year of Richard II. John of Gaunt erected at Tetbury in Staffordshire a court of minstrels, with a full power to receive suit and service from the men of this profession within five neighbouring counties, to enact laws, and determine their controversies; and to apprehend and arrest such of them as should refuse to appear at the said court, annually held on the 16th of August. For this they had a charter, by which they were empowered to appoint a king of the minstrels, with four officers, to preside over them. These were every year elected with great ceremony; the whole form of which is described by Dr Plott: in whose time, however, they seem to have become mere musicians.

Even so late as the reign of king Henry VIII. the reciters of verses or moral speeches learnt by heart, intruded without ceremony into all companies; not only in taverns, but in the houses of the nobility themselves. This we learn from Erasmus, whose argument led him only to describe a species of these men who did not sing their compositions; but the others that did, enjoyed without doubt the same privileges.

We find that the minstrels continued down to the reign of Elizabeth; in whose time they had lost much of their dignity, and were sinking into contempt and neglect. Yet still they sustained a character far superior to any thing we can conceive at present of the singers of old ballads.

When queen Elizabeth was entertained at Killingworth castle by the earl of Leicester in 1575, among the many devices and pageants which were exhibited for her entertainment, one of the personages introduced was that of an ancient minstrel, whose appearance and dress are so minutely described by a writer there present, and gives us so distinct an idea of the character, that we shall quote the passage at large.

"A person very meet seemed he for the purpose, of a xlv. years old, apparelled partly as he would himself. His cap off: his head seemingly rounded tonsterwise: fair-kembed, that, with a sponge daintly dipt in a little capon's grease, was finely smoothed, to make it shine like a mallard's wing. His beard smugly shaven: and yet his shirt after the new trink, with ruffs fair starched, sleeked and glistering like a pair of new shoes, marshalled in good order with a setting stick, and strut, 'that' every ruff stood up like a wafer. A side [i. e. long] gown of Kendale green, after the freshness of the year now, gathered at the neck with a narrow gorget, fastened afore with a white clasp and a keeper close up to the chin; but easily, for heat, to undo when he list. Seemingly begirt in a red caddis girdle: from that a pair of capped Sheffield knives hanging a' two sides. Out of his bosom drawn from a lappet of his napkin edged with a blue lace, and marked with a D for Damian; for he was but a batchelor yet.

"His gown had side [i. e. long] sleeves down to mid-leg, slit from the shoulder to the hand, and lined with white cotton. His doublet-sleeves of black worsted: upon them a pair of points of tawny-chamlet laced along the wrist with blue threaden pointes. A wealt towards the hands of fustian-a-napes. A pair of red neather stocks. A pair of pumps on his feet, with a cross cut at his toes for corns; not new indeed, yet cleanly blackt with soot, and shining as a shoing horn. Minstrel, Mint.

"About his neck a red ribband suitable to his girdle. His harp in good grace dependent before him. His wrest tyed to a green lace and hanging by: under the gorget of his gown a fair flaggon chain, (pewter for) silver, as a squire Minstrel of Middlesex, that travelled the country this summer season, unto fair and worshipful mens houses. From his chain hung a scutcheon, with metal and colour, resplendent upon his breast, of the ancient arms of Islington."

—This minstrel is described as belonging to that village. We suppose such as were retained by noble families, wore their arms hanging down by a silver chain as a kind of badge. From the expression of Squire Minstrel above, we may conclude there were other inferior orders, as Yeomen Minstrels, or the like.

This minstrel, the author tells us a little below, "after three lowly courtesies, cleared his voice with a hem . . . and wiped his lips with the hollow of his hand for 'filing his napkin; tempered a string or two with his wrest; and, after a little warbling on his harp for a prelude, came forth with a solemn song, warranted for story out of king Arthur's acts, &c."

Towards the end of the 16th century, this class of men had lost all credit, and were sunk so low in the public opinion, that in the 39th year of Elizabeth a statute was passed by which "minstrels, wandering abroad" were included among "rogues, vagabonds, and sturdy beggars," and were adjudged to be punished as such. This act seems to have put an end to the profession, for after this time they are no longer mentioned.

MINT, the place in which the king's money is coined. See COINAGE.

There were anciently mints in almost every county in England; but the only mint at present in the British dominions is that in the tower of London. The officers of the mint are, 1. The warden of the mint, who is the chief; he oversees the other officers, and receives the bullion. 2. The master-worker, who receives the bullion from the warden, causes it to be melted, delivers it to the moneyers, and, when it is coined, receives it again. 3. The comptroller, who is the overseer of all the inferior officers, and sees that all the money is made to the just assize. 4. The assay-master, who weighs the gold and silver, and sees that it is according to the standard. 5. The auditor, who takes the accounts. 6. The surveyor of the melting; who, after the assay-master has made trial of the bullion, sees that it is cast out, and not altered after it is delivered to the melter. 7. The engraver; who engraves the stamps and dyes for the coinage of the money. 8. The clerk of the irons; who sees that the irons are clean and fit to work with. 9. The melter; who melts the bullion before it be coined. 10. The provost of the mint; who provides for and

oversees

overfees all the moneyers. 11. The blanchers, who anneal and cleanfe the money. 12. The moneyers; fome of whom forge the money, fome fhear it, fome round and mill it, and fome ftamp and coin it. 13. The porters, who keep the gate of the mint.

Mint-*Marks*. It hath been ufual, from old time, to oblige the mafters and workers of the mint, in the indentures made with them, "to make a privy mark in all the money that they made, as well of gold as of filver, fo that another time they might know, if need were, and witte which moneys of gold and filver among other of the fame moneys, were of their own making, and which not." And whereas, after every trial of the pix at Weftminfter, the mafters and workers of the mint, having there proved their moneys to be lawful and good, were immediately entitled to receive their *quietus* under the great feal, and to be difcharged from all fuits or actions concerning thofe moneys, it was then ufual for the faid mafters and workers to change the privy mark before ufed for another, that fo the moneys from which they were not yet difcharged might be diftinguifhed from thofe for which they had already received their *quietus;* which new mark they then continued to ftamp upon all their moneys, until another trial of the pix gave them alfo their *quietus* concerning thofe.

The pix is a ftrong box with three locks, whofe keys are refpectively kept by the warden, mafter, and comptroller of the mint; and in which are depofited, fealed up in feveral parcels, certain pieces taken at random out of every *journey*, as it is called; that is, out of every 15 pounds weight of gold, or 60 pounds weight of filver, before the fame is delivered to the proprietors. And this pix is, from time to time, by the king's command, opened at Weftminfter, in the prefence of the lord-chancellor, the lords of the council, the lords-commiffioners of the treafury, the juftices of the feveral benches, and the barons of the exchequer; before whom a trial is made, by a jury of goldfmiths impannelled and fworn for that purpofe, of the collective weights of certain parcels of the feveral pieces of gold and filver taken at random from thofe contained in the pix; after which thofe parcels being feverally melted, affays are then made of the bullion of gold and filver fo produced, by the melting certain fmall quantities of the fame againft equal weights taken from the refpective trial-pieces of gold and filver that are depofited and kept in the exchequer for that ufe. This is called the *trial of the pix;* the report made by the jury upon that trial is called the *verdict of the pix* for that time; and the indented trial-pieces juft above-mentioned, are certain plates of ftandard gold and ftandard filver, made with the greateft care, and delivered in upon oath, from time to time as there is occafion, by a jury of the moft able and experienced goldfmiths, fummoned by virtue of a warrant from the lords of the treafury to the wardens of the myftery of goldfmiths of the city of London for that purpofe; and which plates being fo delivered in, are divided each, at this time, into feven parts by indentures, one of which parts is kept in his majefty's court of exchequer at Weftminfter, another by the faid company of goldfmiths, and two more by the officers of his majefty's mint in the tower; the remaining three being for the ufe of the mint, &c. in Scotland. The pix has fometimes been tried every year, or even oftener, but fometimes not more than once in feveral years: and from hence is underftood how it comes to pafs, that, among the pieces that are dated as well as marked, three or more different dates are fometimes found upon pieces impreffed with the fame mark; and again, that different marks are found upon pieces bearing the fame date. Thefe marks are firft obfervable upon the coins of king Edward III.; the words above quoted concerning thofe marks are from the indentures made with the lord Haftings, mafter and worker to king Edward IV.; and the marks themfelves continued to be ftamped very confpicuoufly upon the moneys, till the coinage by the mill and fcrew was introduced and fettled after the Reftoration, in the year 1662: fince which time, the moneys being made with far greater regularity and exactnefs than before, thefe marks have either been totally laid afide, or fuch only have been ufed as are of a more fecret nature, and only known to the officers and engravers concerned in the coinage: and indeed the conftant practice that has ever fince prevailed, of dating all the feveral pieces, has rendered all fuch marks of much lefs confequence than before.

Mint, in botany. See Mentha.

MINUET, a very graceful kind of dance, confifting of a coupee, a high ftep, and a balance: it begins with a beat, and its motion is triple.

The invention of the minuet feems generally to be afcribed to the French, and particularly to the inhabitants of the province of Poictou. The word is faid by Menage and Furetiere to be derived from the French *menue* or *menu*, "fmall, or little;" and in ftrictnefs fignifies a fmall pace. The melody of this dance confifts of two ftrains, which, as being repeated, are called *reprifes*, each having eight or more bars, but never an odd number. The meafure is three crotchets in a bar, and is thus marked $\frac{3}{4}$, though it is commonly performed in the time $\frac{6}{8}$. Walther fpeaks of a minuet in Lully's opera of *Roland*, each ftrain of which contains ten bars, the fectional number being 5; which renders it very difficult to dance.

MINUTE, in geometry, the 60th part of a degree of a circle.

Minute *of Time*, the 60th part of an hour.

Minute, in architecture, ufually denotes the 60th, fometimes the 30th, part of a module. See Architecture.

Minute is alfo ufed for a fhort memoir, or fketch of a thing taken in writing.

MINUTIUS felix. See Felix.

MIQUELETS, a name given to the Spaniards who inhabit the Pyrenean mountains on the frontiers of Arragon and Catalonia, and live by robbing.

MIQUELON, a fmall defert ifland to the fouthweft of Cape May in Newfoundland, ceded to the French by the peace of 1763, for drying and curing their fifh. W. Long. 54. 30. N. Lat. 47. 22.

MIRABILIS, Marvel of Peru; a genus of the monogynia order, belonging to the pentandria clafs of plants.

The moft remarkable fpecies are,

1. The jalappa, or common marvel of Peru, hath a large, thick, flefhy root; an upright, thick, jointed ftalk, dividing and branching numeroufly, widely, and

Mirabilis. and erectly, a yard or more high; garnished with oblong, broad, opposite leaves; and all the branches and shoots terminated by numerous flowers in clusters, of different colours in the varieties. Of this there are varieties with white flowers—with yellow flowers—with purple flowers—with red flowers—with white and yellow flowers—white and purple flowers—purple and yellow flowers—red and yellow flowers. Several other varieties often rise from seed; and it is remarkable that although several of the above colours and variegations are sometimes common to the same plant, yet it is rare that a plant of this species produces flowers of one of those colours alone; sometimes, however, the same plant will exhibit only white and purple flowers separate, and sometimes both colours in the same flowers, intermixed with the plain ones: the same is also observable in the red and yellow; others have plain flowers of several different colours, and sometimes variegated flowers also on the same plants. The root of this species was supposed to be the true officinal jalap, but which is since discovered to be the root of a species of *convolvulus*.

2. The longiflora, or long-flowered mirabilis, hath a large, thick, fleshy root; a thick stalk, dividing low into many declinated spreading branches, extending two or three feet every way; large, heart-formed, hairy, viscous leaves, in opposite pairs; and all the branches and shoots terminated by white flowers in clusters, having very long tubes, nodding downward.

3. The dichotoma, dichotomous, or forked mirabilis; hath a thick fleshy root; an upright, thick, swollen, jointed stem, branching forkedly two or three feet high; oblong opposite leaves; and smallish red flowers at the axillas, singly and close-sitting.

All these plants flower in July, continuing in plentiful succession until October, very conspicuous and elegant. They have the singularity of being shut all day, and expanding towards the evening when the sun declines; hence the inhabitants of the Indies, where they grow naturally, called them *four o'clock flowers:* their time of opening here, however, depends on the weather; for if cloudy, or that the sun is not very vehement, they often open great part of the day.

They are naturally perennial in root, which, however, if not preserved here in winter, prove but of one year's duration; but if sheltered from frost and wet during the winter season, they will remain alive, and shoot out strongly again in spring: in this country, however, the plants are commonly considered as annuals; because they rise from seed in the spring, and the same year produce flowers and perfect seed; and if left to nature in the open air, totally perish in winter, at the first attack of frost or excessive wet; but, as aforesaid, if in autumn, when the stalks begin to assume a state of decay, the roots are taken up, and preserved in sand in a dry room all winter, and planted again in spring, they shoot out afresh stronger than at first, and sometimes obtain four or five feet stature, with very spreading heads; or if plants growing in pots, having the stems cut down in autumn, and the pots placed in a green-house, or garden-frames under glasses, the roots may also be preserved sound, and will shoot out again in spring as above.

The roots generally become large, tuberous, and fleshy, covered with a dark rind.

All the species are of a tender nature, scarcely able to endure the open air here fully day and night, until May or June; that is, they being raised from seed in spring, chiefly in hot-beds under glasses, continued and forwarded there until the beginning of June, then fully exposed in the borders or pots, they become large branchy plants in July and August, and continue flowering until October or November, till prevented by the cold.

They are all elegant furniture for the principal compartments of the pleasure-ground, they being both very ornamental in their large branchy growth, closely garnished with leaves; and, by flowering so numerously, seem as if entirely covered with flowers, in constant plentiful succession from July till the beginning of winter, as aforesaid.

The roots of all these plants is a strong purgative, and given in a double quantity operate equal to the true jalap.

The propagation of all the species is by seed in the spring, either in a warm border, or in a hot-bed; but the latter will forward the plants to considerably the earliest and greatest degree of perfection.

Miracle. MIRACLE, is defined by Dr Samuel Clarke, to be a work effected in a manner different from the common and regular method of providence, by the interposition either of God himself, or some intelligent agent superior to man.

It has been much controverted, whether true miracles can be worked by any less power than the immediate power of God; and whether to complete the evidence of a miracle, the nature of the doctrine pretended to be proved by it is necessary to be taken into the consideration. The above learned author undertakes to set this matter in a clear light, as follows.

In respect to the power of God, and the nature of the things themselves, all things that are possible at all, are equally easy to be done: it is at least as great an act of power to cause the sun to move at all, as to cause it at any time to stand still; yet this latter we call a *miracle*, the former not.

What degrees of power God may reasonably be supposed to have communicated to created beings or subordinate intelligences, is impossible for us to determine: therefore a miracle is not rightly defined to be such an effect as could not have been produced by any less power than the divine omnipotence. There is no instance of any miracle in scripture, which to an ordinary spectator would necessarily imply the immediate operation of original, absolute, and underived power.

All things that are done in the world, are done either immediately by God himself, or by created intelligent beings, matter not being at all capable of any laws or powers whatsoever; so that all those things which we say are the effects of the natural powers of matter and laws of motion, are properly the effects of God acting upon matter continually and every moment, either immediately by himself, or mediately by some created intelligent beings. Consequently it is no more against the course of nature for an angel to keep a man from sinking in the water, than for a man to hold a stone from falling in the air, by overpowering the law of gravitation; and yet the one is a miracle, the other not so.

The only possible ways by which a spectator may certainly

certainly and infallibly diftinguifh whether miracles be the works either immediately of God himfelf, or of fome good angel employed by him; or whether, on the contrary, they are the works of evil fpirits, are thefe: If the doctrine attefted by miracles, be in itfelf impious, or manifeftly tending to promote vice; then, without all queftion, the miracles, how great foever they may appear to us, are neither worked by God himfelf, nor by his commiffion. If the doctrine itfelf be indifferent, and at the fame time there be worked other miracles more and greater than the former, then that doctrine which is attefted by the fuperior power muft neceffarily be believed to be divine: this was the cafe of Mofes and the Egyptian magicians. If, in the laft place, the doctrine attefted by miracles tends to promote the honour of God, and the practice of righteoufnefs among men; and yet neverthelefs be not in itfelf demonftrable, nor could without a revelation be difcovered to be actually true, and there is no pretence of more and greater miracles to contradict it, which is the cafe of the doctrine and miracles of Chrift; then the miracles are unqueftionably divine, and the doctrine muft, without all controverfy, be acknowledged as an immediate and infallible revelation from God.

The Lord Bacon obferves, that a miracle was never wrought by God to convert an atheift, becaufe the light of nature might have led him to confefs a God: but miracles, fays he, are defigned to convert idolaters and the fuperftitious, who have acknowledged a deity, but erred in the manner of adoring him; becaufe no light of nature extends fo far as fully to declare the will and true worfhip of God.

Acofta inquiring into the caufe why miracles are not wrought by the prefent miffionaries for the converfion of heathen nations, as they were by the Chriftians of the primitive ages, gives this as one reafon: That the Chriftians at firft were ignorant men, and the Gentiles learned; but now, on the contrary, all the learning in the world is employed in the defence of the gofpel, and there is nothing but ignorance to oppofe it; and there can be no need of farther miracles in fo good a caufe, when it is in the hands of fuch able advocates againft fuch weak adverfaries. See the article Abridgment.

MIRANDA-de-Ebro, a town of Spain in Old Caftile, with a ftrong caftle; feated in a country that produces excellent wine. The town is divided into two parts by the river, over which there is a handfome bridge. W. Long. 3. 10. N. Lat. 42. 52.

MIRANDE, a town of Gafcony in France, capital of the county of Aftarac; feated on a mountain near the river Baufe. E. Long. 0. 21. N. Lat. 42. 53.

MIRANDO-de-Douro, or *Duero*, a ftrong town of Portugal, and capital of the province of Tra-los-Montes, with a bifhop's fee. It is well fortified, and feated on a rock near the confluence of the rivers Douro and Frefna. W. Long. 5. 40. N. Lat. 41. 30.

MIRANDOLA, a town of Italy, and capital of a duchy of the fame name, fituate between the duchies of Mantua and Modena. It is a pretty large place, well fortified, and has alfo a ftrong citadel and fort. It has been feveral times taken and retaken; the laft time by the king of Sardinia in 1742. E. Long. 11. 5. N. Lat. 44. 52.

MIRANDULA. See Picus.

MIRIAM, fifter of Aaron and Mofes, makes two or three remarkable appearances in fcripture. It was owing to her that her mother was employed by Pharaoh's daughter as nurfe to Mofes. She put herfelf at the head of the women of Ifrael after their paffage through the Red-Sea, in order to fing the fong which the men had fung before. She joined with her brother Aaron in murmuring againft Mofes, and was feverely chaftifed for that action; for fhe became leprous, and continued feparate from the reft without the camp for feven days. She died before her brothers, though in the fame year with them, and was buried at the public expence.

MIRROR, a name for a looking-glafs, or any polifhed body, whofe ufe is to form the images of diftant objects by reflexion of the rays of light. See Reflexion.

Mirrors are either plain, convex, or concave. The firft reflect the rays of light in a direction exactly fimilar to that in which they fall upon them, and therefore reprefent bodies of their natural magnitude. The convex ones make the rays diverge much more than before reflexion, and therefore greatly diminifh the images of thofe objects which they fhew: while the concave ones, by collecting the rays into a focus, not only magnify the objects they fhow, but will burn very fiercely when expofed to the rays of the fun; and hence they are commonly known by the name of *burning mirrors*. See Burning-*Mirrors*.

In ancient times the mirrors were made of fome kind of metal; and from a paffage in the Mofaic writings we learn that the mirrors ufed by the Jewifh women were made of brafs. The Jews certainly had been taught to ufe that kind of mirrors by the Egyptians; from whence it is probable, that brazen mirrors were the firft kind ufed in the world. Any kind of metal indeed, when well polifhed, will reflect very powerfully; but of all others filver reflects the moft, though it hath been in all countries too expenfive a material for common ufe. Gold alfo is very powerful; and metals, or even wood, gilded and polifhed, will act very powerfully as burning mirrors. Even polifhed ivory, or ftraw nicely plaited together, will form mirrors capable of burning, if on a large fcale.

Since the invention of glafs, and the application of quickfilver to it, became generally known, it hath been univerfally employed for thofe plain mirrors ufed as ornaments to houfes; but in making reflecting telefcopes, they have been found much inferior to metallic ones. It doth not appear that the fame fuperiority belongs to the metalline burning mirrors, confidered merely as burning-glaffes; fince the mirror with which Mr Macquer melted platina, though only 22 inches diameter, and which was made of quickfilvered glafs, produced much greater effects than M. Villette's metalline fpeculum, which confiderably exceeded it in fize. It is very probable, however, that this mirror of M. Villette's was by no means fo well polifhed as it ought to have been; as the art of preparing the metal for taking the fineft polifh hath but lately been difcovered and publifhed in the Philofophical Tranfactions by Mr Mudge. See Glass-*Grind-*

Grinding, and the *Mechanical Part* of OPTICS.

MIRE-CROW, SEA-CROW, or *Pewit*. See LARUS.

MISADVENTURE, in common language, signifies any unlucky accident which takes place without being forefeen.

MISADVENTURE, in law, has an efpecial fignification for the killing a man partly by negligence, and partly by chance. See HOMICIDE.

MISCHNAH, or MISNAH, the code or collection of the civil law of the Jews. The Jews pretend, that when God gave the written law to Mofes, he gave him alfo another which was not written; and which was preferved by tradition among the doctors of the fynagogue, till Rabbi Judah, furnamed the *Holy*, feeing the danger they were in, through their difperfion, of departing from the traditions of their fathers, judged it proper to reduce them to writing. The mifnah is divided in fix parts: the firft relates to the diftinction of feeds in a field, to trees, fruits, tythes, &c.; the fecond regulates the manner of obferving feftivals; the third treats of women, and matrimonial cafes; the fourth, of loffes in trade, &c.; the fifth is on obligations, facrifices, &c.; and the fixth treats of the feveral forts of purification.

MISDEMEANOUR, in law, fignifies a crime. Every crime is a mifdemeanour; yet the law has made a diftinction between crimes of an higher and a lower nature; the latter being denominated *mifdemeanours*, the former *felonies*, &c. For the underftanding of which diftinction, we fhall give the following definition from Blackftone's Commentaries, vol. iv. 5.

" A crime, or mifdemeanour, is an act *committed* or *omitted*, in violation of a public law, either forbidding or commanding it. This general definition comprehends both *crimes* and *mifdemefnours*; which, properly fpeaking, are mere fynonimous terms; tho' in common ufage, the word *crime* is made to denote fuch offences as are of a deeper and more atrocious dye; while fmaller faults, and omiffions of lefs confequence, are comprifed under the gentler name of *mifdemeanours* only.

MISE, in law-books, is ufed in various fenfes: thus it fometimes fignifies cofts or expences, in which fenfe it is commonly ufed in entering of judgments in actions perfonal. It is alfo ufed for the iffue to be tried on the grand affize; in which cafe, joining of the mife upon the mere right, is putting in iffue between the tenant and demandant, Who has the beft or cleareft right.

MISE alfo fignifies a tax or tallage, &c. An honorary gift, or cuftomary prefent from the people of Wales to every new king or prince of Wales, anciently given in cattle, wine, and corn, but now in money, being 5000 l. or more, is denominated a *mife*: fo was the ufual tribute or fine of 3000 merks paid by the inhabitants of the county palatine of Chefter, at the change of every owner of the faid earldoms, for enjoying their liberties. And at Chefter they have a mifebook, wherein every town and village in the county is rated what to pay towards the mife. The 27 Hen. VIII. c. 26. ordains that lords fhall have all fuch mifes and profits of their lands as they had in times paft, &c.

MISE, is fometimes alfo corruptly ufed for *meafe*, in law French *mees*, " a meffuage;" as a *mife place*, in fome manors, is fuch a meffuage or tenement as anfwers the lord a heriot at the death of its owner. 2. *Inft.* 528.

MISERICORDIA, in law, is an arbitrary fine impofed on any perfon for an offence: this is called *mifericordia*, becaufe the amercement ought to be but fmall, and lefs than that required by magna charta. If a perfon be outrageonfly amerced, in a court that is not of record, the writ called *moderata mifericordia* lies for moderating the amercement according to the nature of the fault.

MISFORTUNE. An unlucky accident.

MISFORTUNE, or chance, in law, a deficiency of the will; or committing of an unlawful act by misfortune or chance, and not by defign. In fuch cafe, the will obferves a total neutrality, and does not co-operate with the deed; which therefore wants one main ingredient of a crime. See CRIME.

Of this, when it affects the life of another, we have fpoken under the article HOMICIDE; and in this place have only occafion to obferve, that if any accidental mifchief happens to follow from the performance of a lawful act, the party ftands excufed from all guilt: but if a man be doing any thing unlawful, and a confequence enfues which he did not forefee or intend, as the death of a man or the like, his want of forefight fhall be no excufe; for, being guilty of one offence, in doing antecedently what is in itfelf unlawful, he is criminally guilty of whatever confequence may follow the firft mifbehaviour.

MISFEASANCE, in law-books, fignifies a trefpafs.

MISLETOE, in botany. See VISCUM.

MISNOMER, in law, a mifnaming or miftaking a perfon's name. The Chriftian name of a perfon fhould always be perfect; but the law is not fo ftrict in regard to furnames, a fmall miftake in which will be difpenfed with to make good a contract, and fupport the act of the party. See PLEA *to Indictment*.

MISO. See DOLICHOS.

MISPRISIONS, (a term derived from the old French, *mefpris*, a neglect or contempt), are, in the acceptation of our law, generally underftood to be all fuch high offences as are under the degree of capital, but nearly bordering thereon: and it is faid, that a mifprifion is contained in every treafon and felony whatfoever; and that, if the king fo pleafe, the offender may be proceeded againft for the mifprifion only. And upon the fame principle, while the jurifdiction of the ftar-chamber fubfifted, it was held that the king might remit a profecution for treafon, and caufe the delinquent to be cenfured in that court, merely for a high mifdemeanour: as happened in the cafe of Roger earl of Rutland, in 43 Eliz. who was concerned in the earl of Effex's rebellion. Mifprifions are generally divided into two forts; negative, which confift in the concealment of fomething which ought to be revealed; and pofitive, which confift in the commiffion of fomething which ought not to be done.

1. Of the firft, or negative kind, is what is called *mifprifion of treafon*; confifting in the bare knowledge and concealment of treafon, without any degree of affent thereto: for any affent makes the party a principal

pal traitor; as indeed the concealment, which was construed aiding and abetting, did at the common law; in like manner as the knowledge of a plot against the state, and not revealing it, was a capital crime at Florence, and other states of Italy. But it is now enacted by the statute 1 & 2 Ph. & Mar. c. 10. that a bare concealment of treason shall be only held a misprision. This concealment becomes criminal, if the party apprised of the treason does not, as soon as conveniently may be, reveal it to some judge of assize or justice of the peace. But if there be any probable circumstances of assent, as if one goes to a treasonable meeting, knowing beforehand that a conspiracy is intended against the king; or, being in such company once by accident, and having heard such treasonable conspiracy, meets the same company again, and hears more of it, but conceals it; this is an implied assent in law, and makes the concealer guilty of actual high-treason.

Misprision of felony is also the concealment of a felony which a man knows, but never assented to; for, if he assented, this makes him either principal or accessory. And the punishment of this, in a public officer, by the statute Westm. 1. 3 Edw. I. c. 9. is imprisonment for a year and a day; in a common person, imprisonment for a less discretionary time; and, in both, fine and ransom at the king's pleasure: which pleasure of the king must be observed, once for all, not to signify any extrajudicial will of the sovereign, but such as is declared by his representatives, the judges in his courts of justice; *voluntas regis in curia, non in camera.*

2. Misprisions, which are merely positive, are generally denominated *contempt* or *high misdemeanours;* of which the principal is the *mal-administration* of such high officers as are in public trust and employment. This is usually punished by the method of parliamentary impeachment: wherein such penalties, short of death, are inflicted, as to the wisdom of the house of peers shall seem proper; consisting usually of banishment, imprisonment, fines, or perpetual disability. Hither also may be referred the offence of *embezzling the public money,* called among the Romans *peculatus;* which the Julian law punished with death in a magistrate, and with deportation, or banishment, in a private person. With us it is not a capital crime, but subjects the committer of it to a discretionary fine and imprisonment.—Other misprisions are, in general, such contempts of the executive magistrate as demonstrate themselves by some arrogant and undutiful behaviour towards the king and government; for a detail of which, *vide* Blackstone's Comment. iv. 22.

MISSAL, the Romish mass-book, containing the several masses to be said on particular days. It is derived from the Latin word *missa,* which, in the ancient Christian church, signified every part of divine service.

MISSEL-BIRD, a species of TURDUS.

MISSIONARIES, such ecclesiastics as are sent by any Christian church into Pagan or Infidel countries, to convert the natives, and establish the Christian religion among them.

There are in France, and other Popish countries, several congregations of missionaries, whose principal end is to be employed on missions, and to inspire into the young clerks that spirit of piety and devotion which is necessary for the worthy discharge of their ministry. Such are the congregations of the priests of the mission, the Eudists, the missionaries of Lyons, and some others. The most remarkable of these congregations is that of the priests of the mission, which consists of secular clergy; who nevertheless make four simple vows, of poverty, chastity, obedience, and perseverance. Their habit is distinguished from that of other ecclesiastics only by a linen-collar four fingers broad, and by their wearing a little tuft of beard.

MISSISIPPI, also called the *river of St Louis,* is one of the largest in the world. Its source is unknown: for it has not been navigated higher than 300 miles below the fall or cataract of St Anthony; and there it is 30 fathoms deep, though at the distance of 2400 miles from its mouth. It discharges itself into the sea by three mouths; and, like the Nile, has periodical inundations, by the melting of snow in the north, so that in May it overflows the country on each side, from 60 to 90 miles, and the innundation continues till near the end of July. In the lowest parts of the country there are morasses, lakes, and canals, along the banks, which are generally covered with trees, and in some places the course of the river is confined between high precipices. Its inundations always leave a great quantity of mud upon the land, and sometimes carry down trees to the river's mouth, where they form new islands, and render the entrance difficult.

MISSON (Francis Maximilian), whose pleadings before the parliament of Paris in favour of the reformers bear genuine marks of eloquence and ability, retired into England after the revocation of the edict of Nantz, and became a strenuous assertor of the Protestant religion. In the years 1687 and 1688, he travelled to Italy as governor to an English nobleman: in consequence of which he published at the Hague, "A new voyage to Italy," 3 vols 12mo; which has been translated into English with many additions. He published also the "Sacred Theatre at Cevennes, or an account of Prophecies and Miracles performed in that part of Languedoc," London 1707. "Observations and remarks of a traveller," 12mo, Hague. He died at London in 1721.

MISTAKE, any wrong action committed, not through an evil design, but through an error of judgment.

MISTAKE, in law. See IGNORANCE.

MISUSER, in law, is an abuse of any liberty or benefit; as "He shall make fine for his MISUSER." Old. Nat. Br. 149. By *misuser* a charter of a corporation may be forfeited; so also an office, &c.

MISY, in natural history, a species of the chalcantha, a fossil very common in the Turkish dominions, and sometimes found in the mines of Cremnitz in Hungary. It is a considerably firm substance, of an irrelar texture, not compact; much resembling some of our more gaudy marcasites, but wanting in their hardness and weight. It is of no determinate shape or size; but is often found in small detached masses, which are usually broad, flat, and very rugged at the edges. As to its medical virtues, they are no other than those of the green vitriol.

MITE, a small coin formerly current, and equal to about one-third part of a farthing.

MITE, in zoology. See ACARUS.

MITELLA, BASTARD AMERICAN SANICLE; a genus of the digynia order, belonging to the decandria claſs of plants. There are two ſpecies, both natives of North America, riſing with annual herbaceous ſtalks from five or ſix to eight or nine inches in height, and producing ſpikes of ſmall whitiſh flowers, whoſe petals are fringed on their edges. They are eaſily propagated by parting their roots; and ſhould be planted in a ſhady ſituation, and in a ſoft loamy ſoil. The fruit of one of the ſpecies is the achiotte, or arnotto.

MITHRIDATE, in pharmacy; an antidote, or compoſition, in form of an electuary, ſuppoſed to ſerve either as a remedy or a preſervative againſt poiſons. See PHARMACY, n° 892.—894. It takes its name from the inventor, Mithridates king of Pontus; who is ſaid to have ſo fortified his body againſt poiſons with antidotes and preſervatives, that when he had a mind to diſpatch himſelf, he could not find any poiſon that would take effect. The receipt of it was found in his cabinet, written with his own hand, and was carried to Rome by Pompey. It was tranſlated into verſe by Damocrates, a famous phyſician; and was afterwards tranſlated by Galen, from whom we have it: though there is room to imagine it has undergone conſiderable alterations ſince the time of its royal preſcriber.

MITHRIDATES, king of Pontus, a renowned general, and at firſt ſucceſsful againſt the Romans: but being finally conquered by Pompey, and his ſon Pharnaces raiſed to the throne, who treated him with unnatural barbarity, he took poiſon; but this proving ineffectual, owing to a ſalutary medicine which he had almoſt conſtantly employed, he was ſlain at his own requeſt by one of his attendants, 63 B. C. aged 72. He was a prince of extraordinary courage, capable of forming and executing the greateſt deſigns. He had travelled a great deal, was learned, fond of men of letters, and ſpoke many languages. He compoſed a treatiſe *De Arcanis Morborum*; which Pompey cauſed to be carried to Rome, and which his freedman Læneus tranſlated into Latin. It was he who compoſed that counter-poiſon which from his name is ſtill called *mithridate*; but his ſanguinary temper darkened the luſtre of his moſt amiable perfections. See PONTUS.

MITRE, a ſacerdotal ornament worn on the head by biſhops and certain abbots on ſolemn occaſions; being a ſort of cap, pointed and cleft at top. The high-prieſt among the Jews wore a mitre or bonnet on his head. The inferior prieſts of the ſame nation had likewiſe their mitres; but in what reſpect they differed from that of the high prieſt, is uncertain. Some contend that the ancient biſhops wore mitres; but this is by no means certain.

MITTAU, the capital of the duchy of Courland. It is ſtrongly fortified; but was taken by the Swedes in 1701, and by the Muſcovites in 1706. E. Long. 23. 51. N. Lat. 56. 44.

MITTIMUS, as generally uſed, hath two ſignifications. 1. It ſignifies a writ for removing or transferring of records from one court to another. 2. It ſignifies a precept, or command in writing, under the hand and ſeal of a juſtice of the peace, directed to the gaoler or keeper of ſome priſon, for the receiving and ſafe keeping of an offender charged with any crime, until he be delivered by due courſe of law.

MITYLENE, (anc. geog.), a celebrated, powerful, and affluent city of Leſbos; nor was it leſs famous for the ſtudy of philoſophy and eloquence. It ſuffered much in the Peloponneſian war from the Athenians; and in the Mithridatic war from the Romans, being taken and deſtroyed: but it ſoon roſe again, having recovered its ancient liberty, by the favour of Pompey, (Velleius, Plutarch). It remained a free city and in power 1500 years. The country of Pittacus, one of the ſeven wiſe men of Greece; of Alcæus, and of Sappho. *Mytillenæi*, or *Mytilinenſes*, the people; who at ſtated times celebrated poetical conteſts, (Plutarch). Cicero calls it a city ennobled by nature and ſituation, eſpecially by the beauty of its edifices, and by its plains, which are pleaſant and fertile. It is ſometimes by the poets joined with Rhodes, (Horace, Martial). *Mitylenæus*, the epithet, (Lucan). It now gives name to the whole iſland, and this as early as the days of Euſtathius; and is itſelf called *Caſtro*.

MIXT, or MIXT BODY, in chemiſtry, that which is compounded of different elements or principles.

MIXTURE, a compound, or aſſemblage of ſeveral different bodies in the ſame maſs. Simple mixture, conſiſts only in the ſimple appoſition of parts of different bodies to each other. Thus, when powders of different kinds are rubbed together, the mixture is only ſimple, and each of the powders retains its particular characters. In like manner, when oil and water are mixed together, though the parts of both are confounded, ſo that the liquor may appear to be homogeneous, we cannot ſay that there is any more than a ſimple appoſition of the parts, as the oil and water may very eaſily be again ſeparated from each other. But the caſe is very different when bodies are *chemically* mixed; for then one or both bodies aſſume new properties, and can by no means be diſcovered in their proper form without a particular chemical proceſs adapted to this purpoſe. Hence chemical mixture is attended with many phenomena which are never obſerved in ſimple mixtures; ſuch as heat, effervеſcence, &c. To chemical mixture belongs the union of acids and alkalies, the amalgamation of metals, ſolution of gums, &c. and upon it depend many of the principal operations of chemiſtry. See that article *paſſim*.

MIZEN, in the ſea-language, is a particular maſt or ſail. The mizen-maſt ſtands in the ſternmoſt part of the ſhip. In ſome great ſhips there are two of theſe; when that next the main-maſt is called the *main-mizen*, and that next the poop the *bonaventure mizen*.

MIZRAIM, or MISRAIM, the dual name of Egypt, uſed in ſcripture to denote the Higher and Lower Egypt, which ſee. It ſometimes occurs ſingular, *Mazor:* 2 Kings xix. Iſaiah xix. Micah vii.

MNIUM, MARSHMOSS; a genus of the order of muſci, belonging to the cryptogamia claſs of plants. There are 18 ſpecies, of which ſeven are natives of Britain; but none have any remarkable property except the two following. 1. The fontanum is an elegant moſs, frequent in bogs, and on the borders of old ſprings. It is from two to four inches high: the ſtalks are ſimple at the baſe, and covered with a ruſty down; but higher up are red, and divided into ſeveral

veral round, ſingle, taper branches, which proceed nearly from the ſame point. The leaves are not more than $\frac{1}{12}$ of an inch long, lanceolate and acute, of a whitiſh green colour, and ſo thinly ſet, that the red ſtalk appears between them. This moſs, as it may be ſeen at a conſiderable diſtance, is a good mark to lead to the diſcovery of clear and cold ſprings. Linnæus informs us, that the Laplanders are well acquainted with this ſign. Mr Withering informs us, that wherever this moſs grows, a ſpring of freſh water may be found without much digging. 2. The hygrometricum grows in woods, heaths, garden-walks, walls, old trees, decayed wood, and where coals or cinders have been laid. It is ſtemleſs, hath tips inverſely egg-ſhaped, nodding, and bright yellow. If the fruit-ſtalk is moiſtened at the baſe with a little water or ſteam, the head makes three or four revolutions: if the head is moiſtened, it turns back again.

MOAB, (anc. geog.), a country of Arabia Petræa; ſo called from Moab the ſon of Lot, to whoſe poſterity this country was allotted by divine appointment, Deut. xi. 9. It was anciently occupied by the Emim, a race of giants extirpated by the Moabites, *ibid.* Moab anciently lay to the ſouth of Ammon, before Sihon the Amorite ſtripped both nations of a part of their territory, afterwards occupied by the Iſraelites, Numb. xxi.; and then Moab was bounded by the river Arnon to the north, the Lacus Aſphaltites to the weſt, the brook Zared to the ſouth, and the mountains Abarim to the eaſt.

MOAT, or Ditch, in fortification, a deep trench dug round the rampart of a fortified place, to prevent ſurpriſes.

The brink of the moat, next the rampart, is called the *ſcarpe;* and the oppoſite one, the *counterſcarpe.*

A dry moat round a large place, with a ſtrong garriſon, is preferable to one full of water; becauſe the paſſage may be diſputed inch by inch, and the beſiegers, when lodged in it, are continnally expoſed to the bombs, granades, and other fire-works, which are thrown inceſſantly from the rampart into their works. In the middle of dry moats, there is ſometimes another ſmall one, called *cunette;* which is generally dug ſo deep, till they find water to fill it.

The deepeſt and broadeſt moats are accounted the beſt; but a deep one is preferable to a broad one: the ordinary breadth is about 20 fathoms, and the depth about 16.

To drain a moat that is full of water, they dig a trench deeper than the level of the water, to let it run off; and then throw hurdles upon the mud and ſlime, covering them with earth or bundles of ruſhes, to make a ſure and firm paſſage.

MOCHO, Moco, or *Mokha;* by ſome ſuppoſed to be the Muſa or Muza of Ptolemy, is a port and town on the Red-Sea, of conſiderable trade; contains about 10,000 inhabitants, Jews, Armenians, and Mohammedans, is ſurrounded with walls after the ancient manner, and has four gates and four towers, the laſt mounted with cannon, but no ditch. It gives name to a kingdom extending along the moſt ſouthern coaſt of Arabia; of which that part which lies next the ſea is a dry barren deſart, in ſome places 10 or 12 leagues over; but bounded by mountains, which being well watered, enjoy an almoſt perpetual ſpring; and beſides coffee, the peculiar produce of this country, yields corn, grapes, myrrh, frankincenſe, caſſia, balm, gums of ſeveral ſorts, mangos, dates, pomegranates, &c. The weather here is ſo hot and ſultry in ſummer, eſpecially when the ſouth wind blows, that it would be unſupportable, if it was not mitigated by the cool breezes that generally blow from the mountains on the north, or the Red and Arabic Seas on the weſt and eaſt. The heat in winter is equal to that of our warmeſt ſummers; and it is very ſeldom that either clouds or rain are ſeen. The city of Mocho is now the emporium for the trade of all India to the Red-Sea. The trade was removed hither from Aden, in conſequence of the prophecy of a ſheik, much revered by the people, who foretold, that it would ſoon become a place of extenſive commerce, notwithſtanding its diſadvantageous ſituation. It ſtands cloſe to the ſea, in a large, dry, and ſandy plain, that affords no good water within 20 miles of the city; what they drink comes from Moſa, and coſts as dear as ſmall-beer in England. The water near the town, as it is thought, produces a worm, which the naturaliſts call the *dracunculus,* which is about two feet and a half long, very ſlender, and breeds in the fleſhy parts of the body: in extracting it great care muſt be uſed, the conſequence being dangerous if any part of it remains in the body. The buildings here are lofty, and tolerably regular, having a pleaſant aſpect from Mecca. The ſteeples of ſeveral moſques are very high, preſenting themſelves to view at a great diſtance. Their markets are well ſtored with beef, mutton, lamb, kid, camels, and antelopes fleſh, common fowls, Guinea hens, partridges, and pigeons. The ſea affords plenty of fiſh, but not ſavoury; which ſome think proceeds from the extreme ſaltneſs of the water, and the nature of their aliment. The markets are alſo ſtocked with fruit, ſuch as grapes, peaches, apricots, quinces, and nectarines; although neither ſhrub nor tree is to be ſeen near the town, except a few date-trees. Frequently no rain falls here in two or three years, and ſeldom more than a ſhower or two in a year; but in the mountains, at the diſtance of about 20 miles from Mokha, the earth is watered with a gentle ſhower every morning, which makes the vallies fertile in corn, and the fruits natural to the climate. The Arab inhabitants, though remarkably grave and ſuperſtitious, are ſaid to be extremely covetous and hypocritical; robbing, thieving, and committing piracy, without the leaſt ſcruple or remorſe. The Engliſh and Dutch companies have handſome houſes here, and carry on a great trade in coffee, olibanum, myrrh, aloes, liquid ſtorax, white and yellow arſenic, gum-arabic, mummy, balm of Gilead, and other drugs. One inconvenience, however, they ſuſtain from the violence and exactions of the Arabian princes; but the king's cuſtoms are eaſy, being fixed at *three per cent.* to Europeans. Of the coins at Mocha, the moſt current is the camaſſie, which riſes and falls in value at the banker's diſcretion: they are from 50 to 80 for a current dollar, which is but an imaginary ſpecies, being always reckoned one and a half *per cent.* lower than Spaniſh dollars. As to their weights, they are almoſt infinite,

infinite, according to the nature of the thing to be weighed: they have the banian weight; the magnet; the ambergriſe; the agala; the gold and ſilver weights, &c.

MOCKING-BIRD, in ornithology. See TURDUS.

MOCOCO. See LEMUR.

MODE, in metaphyſics, denotes the manner of a thing's exiſtence. See METAPHYSICS, n° 50. 51. 55.—86.

MODE, in muſic; a regular diſpoſition of the air and accompaniments relative to certain principal ſounds upon which a piece of muſic is formed, and which are called the *eſſential ſounds of the mode.*

There is this difference between the mode and the tone, that the latter only determines the principal ſound, and indicates the place which is moſt proper to be occupied by that ſyſtem which ought to conſtitute the baſs of the air; whereas the former regulates the thirds, and modifies the whole ſcale agreeably to its fundamental ſounds.

Our *modes* are not, like thoſe of the ancients, characterized by any ſentiment which they tend to excite, but reſult from our ſyſtem of harmony alone. The ſounds eſſential to the mode are in number three, and form together one perfect chord. 1. The tonic or key, which is the fundamental note both of the tone and of the mode. (See TONE and TONIC). 2. The dominant, which is a fifth from the tonic. (See DOMINANT). 3. The mediant, which properly conſtitutes the *mode*, and which is a third from the ſame tonic. As this third may be of two kinds, there are of conſequence two different modes. When the mediant forms a greater third with the tonic, the mode is major; when the third is leſſer, it is minor.

The major mode is immediately generated by the reſonance of ſounding bodies, which exhibit the third major of the fundamental ſound: but the minor mode is not the product of nature; it is only found by analogy and inverſion. This is equally true upon the ſyſtem of Sig. Tartini as upon that of M. Rameau.

This laſt author, in his various and ſucceſſive publications, has explained the origin of this minor mode in different ways, of which his interpreter M. D'Alembert was ſatisfied with none. It is for this reaſon that he has founded this origin on a different principle which cannot be better explained than in the words of that eminent geometrician. See MUSIC, Art. 28, 29, 30 and 31.

When the mode is once determined, every note in the ſcale aſſumes a name expreſſive of its relation to the fundamental ſound, and peculiar to the place which it occupies in that particular mode. We ſubjoin the names of all the notes ſignificant of their relative values and places in each particular *mode*, taking the octave of *ut* as an example of the major *mode*, and of *la* as an example of the minor.

Major,	*ut*	*re*	*mi*	*fa*	*ſol*	*la*	*ſi*	*ut*,
Minor,	*la*	*ſi*	*ut*	*re*	*mi*	*fa*	*ſol*	*la*.
	Tonic.	Second note.	Mediant.	Sub-dominant, or Fourth note,	Dominant.	Sub-dominant, or Sixth note,	Seventh note.	Octave.

It is neceſſary to remark, that when the ſeventh note is only a ſemitone diſtant from the higheſt in the octave, that is to ſay, when it forms a third major with the dominant, as *ſi* natural in the major *mode*, or *ſol* ſharp in the minor, that ſeventh ſound is then called a *ſenſible note*, becauſe it diſcovers the tonic and renders the tone apreciable.

Nor does each gradation only aſſume that name which is ſuitable to it; but the nature of each interval is determined according to its relation to the *mode.* The rules eſtabliſhed for this are as follow:

1. The ſecond note muſt form a ſecond major above the tonic, the fourth note and the dominant ſhould form a fourth and fifth exactly true; and this equally in both modes.

2. In the major mode, the mediant or third, the ſixth and the ſeventh from the tonic, ſhould always be major; for by this the mode is characterized. For the ſame reaſon theſe three intervals ought always to be minor in the minor mode: nevertheleſs, as it is neceſſary that the ſenſible note ſhould likewiſe there be perceived, which cannot be effectuated without a falſe relation whilſt the ſixth note ſtill remains minor; this occaſions exceptions, of which in the courſe of the air or harmony care muſt be taken. But it is always neceſſary that the cleff, with its tranſpoſitions, ſhould preſerve all the intervals, as determined with relation to the tonic, according to the ſpecies of the *mode.* For this a general rule will be found at the word *Cleff* in Rouſſeau's Muſical Dictionary.

As all the natural chords in the octave of *ut* give, with relation to that tonic, all the intervals preſcribed for the major *mode*, and as the caſe is the ſame with the octave of *la* for the minor mode, the preceding example, which was only given that we might have an opportunity of naming the notes, may likewiſe ſerve as a formula for the rule of the intervals in each *mode.*

This rule is not, as one might imagine, eſtabliſhed upon principles that are merely arbitrary: it has its ſource in the generation of harmony, at leaſt in a certain degree. If you give a perfect major chord to the tonic, to the dominant, and the ſub-dominant, you will have all the ſounds of the diatonic ſcale for the major *mode:* to obtain that of the minor, leaving ſtill its third major to the dominant, give a third minor to the two other chords. Such is the analogy of the mode.

As this mixture of major and minor chords introduces into the minor mode a falſe relation between the ſixth and the ſenſible note, to avoid this falſe relation, they ſometimes give the third major to the fourth note in aſcent, or the third minor to the dominant in deſcending, chiefly by inverting the chords; but theſe in this caſe are licences.

There are properly no more than two *modes*, as we have ſeen: but as there are twelve different ſounds in the octave which may be made fundamental ſounds, and of conſequence form as many keys or tones; and as each of theſe tones are ſuſceptible of the major or minor mode, muſic may be compoſed in twenty-four modes or manners. Nay, in the manner of writing muſic, there are even thirty-four paſſable modes: but in practice ten are excluded, which when thoroughly examined are nothing elſe but a repetition of the other ten, under relations much more difficult, in which all the

Mode.

the chords muſt change their names, and where it muſt coſt any one ſome trouble to know what he is about. Such is the major mode upon a note raiſed above its natural pitch by a ſemitone, and the minor mode upon a note depreſſed by a ſemitone. Thus, inſtead of compoſing upon *ſol* ſharp with a third major, it is much more eligible to operate upon *la* flat, which will give you an opportunity to employ the ſame tones; and inſtead of compoſing upon *re* flat with a third minor, you will find it more convenient to chooſe *ut* ſharp for the ſame reaſon; viz. on one hand to avoid a *fa* with a double ſharp, which would be equivalent to a *ſol* natural; and on the other hand a *ſi* with a double flat, which would become a *la* natural.

The compoſer does not always continue in the ſame *mode*, nor in the ſame *key*, in which he has begun an air; but, whether to alter the expreſſion or introduce variety, *modes* and *keys* are frequently changed, according to the analogy of harmony; yet always returning to thoſe which have been firſt heard: this is called *modulation*.

From thence ariſes a new diviſion of *modes* into ſuch as are *principal* and ſuch as are *relative:* the principal is that in which the piece begins and ends; the relative modes are ſuch as the compoſer interweaves with the principal in the flow of the harmony. (See Modulation).

Others have propoſed a third ſpecies, which they call a *mixed mode*, becauſe it participates the modulation of both the others, or rather becauſe it is compoſed of them; a mixture which they did not reckon an inconveniency, but rather an advantage, as it increaſes the variety, and gives the compoſer a greater latitude both in air and harmony.

This new mode, not being found by the analyſis of the three chords like the two former, is not determined, like them, by harmonics eſſential to the mode, but by an entire ſcale which is peculiar to itſelf, as well in riſing as deſcending; ſo that in the two modes above-mentioned the ſcale is inveſtigated by the chords, and in this mixed mode the chords are inveſtigated by the ſcale. The following notes exhibit the form of this ſcale in ſucceſſion, as well riſing as deſcending:

mi fa ſol la ſi ut re mi.

Of which the eſſential difference is, as to the *melody*, in the poſition of the two ſemitones; of which the firſt is found between the firſt and the ſecond note, and the laſt between the fifth and ſixth: and, with reſpect to the *harmony*, the difference conſiſts in this, that upon its tonic it carries a third minor in the beginning, and major in ending, in the accompaniment of this ſcale, as well in riſing as deſcending, ſuch as it has been given by thoſe who propoſed it, and executed at a ſpiritual concert, May 30. 1751.

They object to its inventor, That his mode has neither chords nor harmony eſſential to itſelf, nor cadences which are peculiar to it, and which ſufficiently diſtinguiſh it from the major or minor mode. He anſwers to this, That the diſtinction of his mode is leſs in harmony than in melody, and leſs even in the mode itſelf than in the modulation; that in its beginning it is diſtinguiſhed from the major mode by its third minor, and in its end from the minor mode by its plagal cadence. To which his opponents reply, That a modulation which is not excluſive cannot be ſufficient to eſtabliſh a mode; and that his muſt inevitably occur in the two other modes, and above all in the minor: and, as to his plagal cadence, that it neceſſarily takes place in the minor mode as often as tranſition is made from the chord of the tonic to that of the dominant, as has long been the caſe in practice, even upon final notes, in plagal modes, and in the tone proper to the fourth. From whence it is concluded, that his mixed mode is not ſo much a particular ſpecies, as a new denomination for the manner of interweaving and combining the major and minor modes, as ancient as harmony, practiſed at all periods: and this appears to be ſo true, that, even when he begins his ſcale, its author will neither venture to give the fifth nor the ſixth to his tonic, for fear leſt by the firſt the tonic ſhould be determined in the minor mode, or the mediant in the major mode by the ſecond. He leaves the harmony equivocal by not filling up his chord.

Mode || Modena.

But whatever objections may be made againſt the mixed mode, whoſe name is rather rejected than its practice, this will not prevent the author from appearing as a man of genius, and a muſician profoundly learned in the principles of his art, by the manner in which he treats it, and the arguments which he uſes to eſtabliſh it.

Mode *Major*. } See Interval.
Mode *Minor*. }

MODEL, in a general ſenſe, an original pattern, propoſed for any one to copy or imitate.

This word is particularly uſed, in building, for an artificial pattern made in wood, ſtone, plaſter, or other matter, with all its parts and proportions, in order for the better conducting and executing ſome great work, and to give an idea of the effect it will have in large. In all great buildings, it is much the ſureſt way to make a model in relievo, and not to truſt to a bare deſign or draught. There are alſo models for the building of ſhips, &c. and for extraordinary ſtaircaſes, &c.

They alſo uſe models in painting and ſculpture; whence, in the academies, they give the term *model* to a naked man or woman, diſpoſed in ſeveral poſtures, to give an opportunity to the ſcholars to deſign him in various views and attitudes.

MODENA, a duchy of Italy, bounded on the ſouth by Tuſcany and the republic of Lucca, on the north by the duchy of Mantua, on the eaſt by the Bologneſe and the territories of the church, and on the weſt by the duchy of Parma; extending in length from ſouth to north about 56 Engliſh miles, and in breadth between 24 and 36, and yielding plenty of corn, wine, and fruits, with mineral waters. In ſome places alſo petroleum is ſkimmed off the furface of the water of deep wells made on purpoſe; and in others is found a kind of earth or tophus, which, when pulveriſed, is ſaid to be an excellent remedy againſt poiſon, fevers, dyſenteries, and hypochondriac diſorders. The country of La Salſa affords ſeveral kinds of petrifactions. The principal rivers are the Croſtolo, Secchia, and Panaro. The family of Eſté, dukes of Modena, is very ancient. They had their name from Eſté, a ſmall city in the diſtrict of Padua. In

In 1753, the prefent duke was appointed imperial vicar-general, field-marfhal, and governor, of the Milanefe during the minority of the archduke Peter Leopold, who was declared governor-general of the Auftrian Lombardy. The duke, though a vaffal of the empire, hath an unlimited power within his own dominions.

MODENA, an ancient city, in Latin *Mutina*, which gives name to a duchy of Italy, and is its capital. It ftands 28 miles eaft of Parma, 44 almoft fouth of Mantua, and 20 weft of Bologna; and is a pretty large and populous, but not a handfome city. It is much celebrated by Roman authors for its grandeur and opulence; but was a great fufferer by the fiege it underwent during the troubles of the triumvirate. It hath long been the ufual refidence of the dukes; and is alfo the fee of a bifhop, who is fuffragan to the archbifhop of Bologna. Mr Keyfler fays, that when Decius Brutus was befieged here by Mark Antony, Hirtius the conful made ufe of carrier-pigeons; and that, even at this day, pigeons are trained up at Modena, to carry letters, and bring back anfwers. This city hath given birth to feveral celebrated perfons, particularly Taffo the poet, Correggio the great painter, Sigonius the civilian and hiftorian, da Vignola the architect, and Montccuculi the imperial general. The tutelary faint of it is named *Geminianus*. The ducal palace is a very noble edifice, in which, among the other fine pictures, the birth of Chrift by Correggio, called *la Notte Felice*, is much celebrated. The only manufacture for which this city is noted, is that of mafks, of which great numbers are exported. The churches of the Jefuits, of the Theatines, and of St Dominic, are well worth viewing. In the college of St Carlo Boromeo between 70 and 80 young noblemen are continually maintained, and inftructed both in the fciences and genteel exercifes. St Beatrix, who was of the family of Efté, is faid to knock always at the gate of the palace three days before any of the family dies. Before moft of the houfes are covered walks, or porticos, as at Bologna. The city is fortified, and on its fouth fide ftands the citadel.

MODERATOR, in the fchools, the perfon who prefides at a difpute, or in a public affembly: thus the prefident of the annual affembly of the church of Scotland is ftyled *moderator*.

MODERN, fomething new, or of our time; in oppofition to what is antique, or *ancient*.

MODERN *Authors*, according to Naude, are all thofe who have wrote fince Boëthius. The modern philofophy commences with Galileo; the modern aftronomy with Copernicus.

MODIFICATION, in philofophy, that which modifies a thing, or gives it this or that manner of being. Quantity and quality are accidents which modify all bodies.

Decree of MODIFICATION, in Scots law, a decree afcertaining the extent of a minifter's ftipend, without proportioning it among the perfons liable in payment.

MODILLIONS, in architecture, ornaments in the corniche of the Ionic, Corinthian, and Compofite columns.

MODIUS, in antiquity, a kind of dry meafure, in ufe among the Romans, for feveral forts of grain.

MODREVIUS (Andreas Frichius), fecretary to Sigifmund Auguftus king of Poland, acquired confiderable reputation by his learning and works. He broke off from the Romifh church, favoured the Lutherans and Anti-trinitarians, and took great pains in order to unite all Chriftian focieties under the fame communion. Grotius has placed him in the clafs of the reconcilers of the different fchemes of religion. His principal work is intitled, *De republica emendanda*.

MODULATION, the art of forming any thing to certain proportion.

MODULATION, in reading, or fpeaking. See READING.

MODULATION, in mufic, derived from the Latin *modulari*. This word in our language is fufceptible of feveral different fignifications. It frequently means no more than an air, or a number of mufical founds properly connected and arranged. Thus it anfwers to what Mr Malcolm underftands by the word *tune*, when he does not exprefsly treat concerning the tuning of inftruments. Thus likewife it expreffes the French word *chant*; for which reafon, in the article MUSIC, we have frequently expreffed the one word by the other. But the precife and technical acceptation to which it ought to be confined, is the art of compofing melody or harmony agreeably to the laws prefcribed by any particular key, that of changing the key, or of regularly and legitimately paffing from one key to another. In what remains to be faid upon the fubject we follow Rouffeau.

Modulation (fays he) is properly the manner of afcertaining and managing the modes; but at this time the word moft frequently fignifies the art of conducting the harmony and the air fucceffively through feveral modes, in a manner agreeable to the ear and conformed to rules.

If the different modes be produced by harmony, from thence likewife muft fpring the laws of modulation. Thefe laws are fimple in conception, but difficult in practice. We proceed therefore to fhew in what they confift.

To modulate properly in the fame tone, it is neceffary, 1. To run through all the founds of it in an agreeable air, frequently repeating the founds which are moft effential to it, and dwelling upon thefe founds with the moft remarkable emphafis; that is to fay, that the chord containing the fenfible notes, and that of the tonic, fhould frequently be heard in it, but under different appearances, and obtained by different procedures to prevent monotony. 2. That repofes or cadences fhould only be eftablifhed upon thefe two chords: the greateft liberty, however, which ought to be taken with the rule is, that a cadence or repofe may be eftablifhed on the chord of the fubdominant. 3. In fhort, that none of the founds of the mode ought ever to be altered; for without quitting it, we cannot introduce a fharp or a flat which does not belong to it, nor abftract any one which in reality does belong to it.

But paffing from one mode to another, we muft confult analogy, we muft confider the relations which a key bears to the other notes in the feries, and to the num-

number of founds common to both the modes, that from whence we pafs, and that into which we enter.

If we pafs from a mode major, whether we confider the fifth from the key as having the moft fimple relation with it except that of the octave, or whether we confider it as the firft found which enters into the harmonics of the fame key, we fhall always find, that this fifth, which is the dominant of the mode, is the chord upon which we may eftablifh the modulation moft analogous to that of the principal key.

This dominant, which conftituted one of the harmonics of the firft key, makes alfo one of its own peculiar key, of which it is the fundamental found. There is then a connection between thefe two chords. Befides, that fame dominant carrying, as well as the tonic, a perfect chord major upon the principle of refonance, thefe two chords are only different one from the other by the diffonance, which paffing from the key to the dominant is the fixth fuperadded, and when reafcending from the dominant to the key is the feventh. Now thefe two chords, thus diftinguifhed by the diffonance which is fuitable to each, by the founds which compofe them when ranged in order, form precifely the octave, or the diatonic fcale, which we call a *gammut*, which determines the mode.

This fame feries of the key, altered only by a fharp, forms the fcale belonging to the mode of the dominant; which fhows how ftriking the analogy is between thefe two tones, and gives the eafieft opportunity of paffing from one to the other by means of one fingle alteration alone. The mode then of the dominant is the firft which prefents itfelf after that of the key in the order of modulations.

The fame fimplicity of relations which we find between a tonic and its dominant, is likewife found between the fame tonic and its fub-dominant; for that fifth, in afcending, which is formed by the dominant with the tonic, is likewife formed by the fub-dominant in defcending: but that fub-dominant does not form a fifth with the tonic. except by inverfion; it is directly a fourth, if we take that tonic below, as it ought to be; and which fixes the degree of their relations: for in this fenfe the fourth, whofe ratio is as 3 to 4, immediately follows the fifth, whofe ratio is as 2 to 3. So that, if that fub-dominant does not enter into the chord of the tonic, in return the tonic enters into its perfect chord. For let *ut mi fol* be the chord of the tonic, that of the fub-dominant fhall be *fa la ut:* thus it is the *ut* which here forms the connection, and the two other founds of this new chord are exactly the two diffonances of the preceding. Befides, we need not alter more founds for this new mode than for that of the dominant; they are both in the one and the other quite the fame chords of the principal mode, except one. Add a flat to the fenfible note *fi* or B, and all the notes in the mode of *ut* or C will ferve for that of *fa* or F. The mode of the fub-dominant then is fcarcely lefs analogous to the principal mode than that of the dominant.

It ought likewife to be remarked, that after having made ufe of the firft modulation in order to pafs from a principal mode *ut* or C, to that of the dominant *fol* or G, we are obliged to make ufe of the fecond to return to the principal mode: for if *fol*, or G, be the dominant in the mode of *ut* or C, *ut* is the fub-dominant in the mode of *fol:* thus one of thefe modulations is no lefs neceffary than the other.

The third found which enters into the chord of the tonic is that of third formed by its mediant; and, after the preceding, it is likewife the moft fimple of relations $\frac{2}{3}\frac{3}{4}\frac{4}{5}$. Here then is a new modulation which prefents itfelf, and which is fo much the more analogous, becaufe two of the founds of the principal tonic enter likewife into the minor chord of its mediant; for the former chord being *ut mi fol*, the latter muft be *mi fol fi*, where it may be perceived that *mi* and *fol* are common. But what renders this modulation a little more remote, is the number of founds which are neceffary to be altered, even for the minor mode, which is moft fuitable to this *mi*. In the article Music (234.) will be found a table for all the modes; and Rouffeau, in his Mufical Dictionary, has given the formula of a fcale both for the major and minor: now, by applying this formula to the minor mode, we find nothing in reality, but the fourth found *fa* heightened by a fharp in defcending; but in rifing, we find two others which are altered, *viz.* the principal tonic *ut*, and its fecond *re*, which here becomes a fenfible note: it is certain that the alteration of fo many founds, and particularly of the tonic, muft remove the mode and weaken the analogy.

If we fhould invert the third as we have inverted the fifth, and take that third below the tonic on the fixth note *la*, which ought here to be called a *fub-mediant*, or the *mediant below*, we fhall form upon this note *la* a modulation more analogous to the principal tone than that of *mi;* for as the perfect chord of this fub-mediant is *la ut mi*, there once more we find, as in that of the mediant, two of the founds which enter into the chord of the tonic, viz. *ut* and *mi:* and moreover, fince the fcale of this new key is compofed, at leaft in defcending, of the fame founds with that of the principal key; and fince it has only two founds altered in afcending, that is to fay, one fewer than the feries of the mediant; it follows that the modulation of this fixth note is preferable to that of the mediant; and by fo much the more, that there the principal tonic forms one of the founds effential to the mode; which is more proper for approximating the idea of the modulation. The *mi* may afterwards follow.

Here then are four founds, *mi fa fol la*, upon each of which we may modulate in paffing from the major mode of *ut*. *Re* and *fi* remain, which are the two harmonics of the dominant. This laft, as being a fenfible note, cannot become a tonic by any proper modulation, at leaft it cannot immediately become one: this would be an abrupt application of ideas too much oppofed to the fame founds, and would likewife be to give it a harmony too remote from the principal found. As to the fecond note *re*, we may likewife, by favour of a confonant procedure in the fundamental bafs, modulate upon it in a third minor; but this muft be only continued for an inftant, that the audience may not have time to forget the modulation of *ut*, which is itfelf altered in that place; otherwife, inftead of returning immediately to *ut*, we muft pafs through intermediate modes, where we muft run great hazard of deviation.

By following the fame analogies, we may modulate in the following order, to make our exit from a minor mode;

 mode; firſt upon the mediant, afterwards the dominant, next the ſub-dominant, then the ſub-mediant, or ſixth note. The mode of each of theſe acceſſory keys is determined by its mediant taken from the principal ſound. For inſtance, iſſuing from the major mode of *ut*, to modulate upon its mediant, we render the mode of that mediant minor; becauſe *ſol*, the dominant of the principal ſound, forms a third minor with that mediant, which is *mi*. On the contrary, in our egreſs from the minor mode of *la*, we modulate upon its mediant *ut* in the major mode; becauſe *mi*, the dominant of the tone from whence we iſſue, forms a third major with the key of that into which we enter, &c.

Theſe rules, comprehended in one general formula, import, that the modes of the dominant and of the ſub-dominant are like that of the tonic, and that the mediant and the ſixth note require a mode oppoſed. We muſt, however, remark, that, by the right which we have of paſſing from the major to the minor, and *vice verſa*, upon the ſame key, we may likewiſe change the order of modes from one key to another; but whilſt we thus remove ourſelves from the natural modulation, we muſt preſently think of our return: for it is a general rule, that every piece of muſic ought to terminate in that key with which it began.

In his Muſical Dictionary, plate B, fig. 6. and 7. Rouſſeau has collected in two examples, which are very ſhort, all the modes to which we may immediately paſs; the firſt, in paſſing from the major mode; and the ſecond, from the minor. Each note indicates a particular modulation; and the value of the notes in each example likewiſe ſhows the relative duration ſuitable to each of theſe modes, according to its relation with the principal mode.

Theſe immediate tranſitions from one mode to another, furniſh us with the means of paſſing by the ſame rules to modes ſtill more remote, and from thence to return to the principal mode, of which we never ſhould loſe ſight. But it is not ſufficient to know what courſe we ought to purſue; we muſt likewiſe be acquainted with the method of entering into it. A ſummary therefore of the precepts which are given in this department ſhall immediately follow.

In melody, in order to diſcover and introduce the modulation which we have choſen, nothing is neceſſary but to render perceptible the alterations which it cauſes in the ſounds of that mode from whence we iſſue, to make them proper for the mode into which we enter. Are we now in the major mode of *ut?* there needs no more than to ſound the note *fa* ſharp, that we may diſcover the mode of the dominant; or a *ſi* flat, that we may ſhew the mode of the ſub-dominant. Afterwards you may run over the ſounds eſſential to the mode in which you enter; if it is well choſen, your modulation will always be juſt and regular.

In harmony, the difficulty is a little increaſed: for as it is neceſſary that the change of modes ſhould be made at the ſame time through all the parts, care muſt be taken of the harmony, and of the air, that we may avoid purſuing different modulations at the ſame time. Huygens has happily remarked, that the prohibition of two fifths in immediate ſucceſſion proceeds upon this rule as its principal: in reality, between two parts it is ſcarcely poſſible to form a number of juſt fifths in uninterrupted ſucceſſion without operating in two different modes.

To introduce a mode, a great many pretend that it is ſufficient to form the perfect chord of its principal ſound, and this is indiſpenſable in order to produce the mode. But it is certain, that the mode cannot be exactly determined but by the chord containing the ſenſible note, or the dominant: we muſt then cauſe this chord to be heard when we enter into a new modulation. The moſt eligible rule would be, That in it the ſeventh, or minor diſſonance, ſhould always be prepared, at leaſt the firſt time in which it is heard: but this method is not practicable in every admiſſible modulation; and provided that the fundamental baſs proceeds by conſonant intervals, that the connection of harmony be obſerved, the analogy of the mode purſued, and falſe relations avoided, the modulation will always be approved. Compoſers preſcribe as another rule, That a mode ſhould not be changed except after a perfect cadence: but this interdict is uſeleſs, and no perſon obſerves it.

All the poſſible methods of paſſing from one mode to another, are reducible to five with reſpect to the major mode, and to four with reſpect to the minor; which, in the Muſical Dictionary, plate B, fig. 8. will be found implied in a fundamental baſs intended for each modulation. If there be any other modulation which cannot be reſolved into ſome one of theſe nine, unleſs that modulation be enharmonic, it muſt infallibly be illegitimate. See ENHARMONIC.

MODULE, in architecture, a certain meaſure, or bigneſs, taken at pleaſure, for regulating the proportions of columns, and the ſymmetry or diſpoſition of the whole building. Architects generally chooſe the ſemidiameter of the bottom of the column for their module, and this they ſubdivide into parts or minutes.

MOEBIUS (Godfrey), profeſſor of phyſic at Iena, was born at Lauch in Thuringia in 1611. He became firſt phyſician to Frederic William elector of Brandenburg, to Auguſtus duke of Saxony, and to William duke of Saxe-Weimar. He wrote ſeveral medicinal works, which are eſteemed; and died at Halle, in Saxony, in 1664.

MOENIUS (Caius), a celebrated Roman conſul, conqueror of the ancient Latins, 338 B. C. He was the firſt who hung up the prows, &c. of the galleys he had taken at the naval engagement of Actium, upon the place where the tribunes harangued the people; from whence it was called the *roſtra*.

MOFFAT, a village of Scotland, in the ſhire of Annandale, 36 miles ſouth-weſt of Edinburgh; famous for its ſulphureous waters; one of the ſprings being uſed for bathing, the other for drinking. Theſe waters are of great ſervice in gripings of the guts, colics, and pains in the ſtomach. Thoſe who are troubled with obſtructions, rheumatic pains, and aches, find great relief both from bathing and drinking. The water is alſo of great uſe in ſcorbutic and ſcrophulous caſes.

MOGULS, or MUNGLS, a celebrated nation of Aſia, whoſe conqueſts formerly were the moſt rapid and extenſive of any people recorded in hiſtory.

The origin of the Moguls, Tartars, and Turks, is univerſally allowed to be the ſame; and they are conſidered as the offspring of part of the ancient Scythians.

Moguls. thians. They themſelves deduce their origin from Japhet, or, as they call him, *Japhis*, the ſon of Noah.

1 Moguls deſcended from Japhet.

His ſon Turk, they ſay, was the firſt king, or khan, of thoſe nations who are now known by the ſeparate names of *Turks*, *Tartars*, and *Moguls*; and the Tartars eſpecially, aſſert that their proper deſignation is *Turks*. To this prince is attributed many of thoſe inventions which barbarous nations commonly aſcribe to their firſt ſovereigns. He was ſucceeded by Taunak; in whoſe reign the whole poſterity of Turk were divided into four large tribes, denominated the *orda's* of Erlat, Gialair, Kaugin, Berlas, or Perlas; of which laſt came the famons Timur Beg, or Tamerlane. From this time to that of Alanza Khan, we meet with nothing remarkable. In his reign the Turks being immerſed in all kinds of luxury, univerſally apoſtatized into idolatry. Having two ſons, Tartar and Mogul, he divided his dominions among them, and thus gave riſe to the two empires of the Tartars and Moguls.

The two nations had not long exiſted before they began to make war upon each other: and after long contention, the event at laſt was, that Il Khan, emperor of the Moguls, was totally overthrown by Siuntz Khan, emperor of the Tartars; and ſo great was the defeat, that the Mogul nation ſeems to have been almoſt exterminated.

2 Almoſt exterminated by the Tartars.

Only two of Il Khan's family ſurvived this diſaſter. Theſe were Kajan his youngeſt ſon, and Nagos his nephew, who were both of an age, and had both been married the ſame year. Theſe two princes, with their wives, had been taken priſoners by Siuntz Khan, but found means to make their eſcape to their own country. Here they ſeized upon all the cattle which had not been carried off by the Tartars; which was eaſily done, as having none to diſpute the property with them; then ſtripping ſome of the ſlain, they took their clothes, and retired into the mountains. They paſſed ſeveral mountains without much difficulty; but at laſt advanced to the foot of one exceedingly high, which had no way over it but a very ſmall path made by certain animals, called in the Tartar language *archara*. This path they found themſelves obliged to make uſe of, tho' it was ſo ſtrait, that only one could paſs at a time, and he was in the moſt imminent danger of breaking his neck at the leaſt falſe ſtep.

3 They arrive in a delightful valley.

Having aſcended the mountain on one ſide by this path, they deſcended by the ſame on the other ſide; and were agreeably ſurpriſed to find themſelves in a moſt delightful track, interſperſed with rivulets and charming meadows, abounding with a vaſt variety of delicious fruits, and incloſed on all ſides by inacceſſible mountains, in ſuch a manner as to ſhelter them from all future purſuits of the Tartars. Here they lived ſome time, and gave this beautiful country the name of *Irgana-kon*, in alluſion to its ſituation; *Irgana* ſignifying, in the old language of the Moguls, a "valley," and *Kon*, a "ſteep height."

In proceſs of time theſe two families very much increaſed. Kajan, whoſe poſterity was the moſt numerous, called his deſcendants *Kajath*: but the people ſpringing from Nagos were divided into two tribes; one of which received the appellation of *Nagoſler*, and the other that of *Durlagan*.

Theſe two Mogul princes and their deſcendants lived in this place for more than 400 years; but the latter then finding it too narrow for them, meditated a return to the country from which their forefathers had been driven. For ſome time, however, they found this impracticable, as the path that conducted their anceſtors had been long ſince deſtroyed. At laſt they diſcovered, that one part of the high mountain abovementioned was not very thick in a certain place; and alſo, that it conſiſted entirely of iron ore. To this, having before ſet fire to a layer of wood, and another of charcoal, laid along the foot of the mountain, they applied 70 large bellows, and at laſt melted the mountain in ſuch a manner, that an opening was made large enough for a loaded camel to paſs; and through this paſſage they all marched out with great joy.

4 From whence they at laſt iſſue, and defeat the Tartars.

The Moguls having thus iſſued as it were from a new world, overthrew the Tartars in their turn; and continued to be a very conſiderable nation till the time of their great hero Temujin, afterwards called *Jenghiz Khan*, whom they extol in the moſt extravagant manner. It is difficult, however, to ſay, at the time Temujin made his appearance, how far the dominions of the Moguls extended, or in what eſtimation they were held by their neighbours. It ſeems to be pretty certain, that great part of the vaſt region now known by the name of *Tartary*, was then in a ſtate of conſiderable civilization, and likewiſe extremely populous, as we find mention made of many cities which the Moguls deſtroyed; and the incredible multitudes whom they ſlaughtered, abundantly ſhew the populouſneſs of the country.

5 State of Aſia at the time of Jenghiz Khan.

On the eaſt, the country of the Moguls and Tartars had the great deſart which divides Tartary from China; on the weſt, it had the empire of Karazm, founded by Mahmud Gazni; and on the ſouth were the countries now known by the name of *Indoſtan*, *Siam*, *Pegu*, *Tonquin*, and *Cochin-China*. Thus it comprehended the eaſtern part of modern Tartary, and all Siberia. This whole region was divided among a great number of *Aymacks*, or *tribes*; who had each one or more khans, according as it was more or leſs numerous, or divided into branches. Among theſe, that of the *Kara-its* was the moſt powerful: their prince aſſumed the title of *Grand Khan*, and among the reſt the Moguls were tributary to him; but, according to the Chineſe hiſtorians, both the one and the other were tributary to the emperor of Kitay or Katay. China was divided into two parts: the nine ſouthern provinces were in the hands of the Chineſe emperors of the Song dynaſty, who kept their court at Hang-chew, the capital of the province of Chekyang: the five northern provinces, excepting part of Skenſi, were poſſeſſed by the Kin, a people of Eaſtern Tartary, from whom are deſcended the Manchew Tartars, at preſent maſters of China. This vaſt dominion was named *Kitay*, or *Katay*, and was divided into two parts: that which belonged to China, was properly called *Kitay*; and the part, which belonged to Tartary, was called *Karakitay*; in which ſome even include the territories of the Moguls, Karaits, and other tribes, which are the ſubject of the preſent hiſtory. The weſtern part of the empire of Kitay was poſſeſſed by a Turkiſh prince, who had lately founded a new kingdom there, called *Hya*; whoſe capital city was Hya-chew, now Ninghya in Shenſi, from whence the kingdom took its name. To the weſt of Hya lay Tangut; a country of great extent, and formerly very powerful; but at that time reduced to a low ſtate, and di-

divided among many princes; ſome of whom were ſubject to the emperor of Hya, and others to the emperor of China. All Tartary to the weſtward, as far as the Caſpian ſea, with the greater part of Little Buckharia, which then paſſed under the general name of *Turkeſtan*, was ſubject to Gurkhan, Khurkhan, or Kavar Khan; to whom even the Gazni monarchs are ſaid to have been tributary. This Ghurkhan had been prince of the Weſtern Kitan or Lyau; who, driven out of Kitay by the King, ſettled in Little Buckharia, and the country to the north, where they founded a powerful ſtate about the year 1124.

6 Deſcent and birth of Temujin.

Thus the Moguls, properly ſo called, had but a very ſmall extent of empire which could be called their own, if indeed they had any, when Temujin made his appearance. This hero is ſaid by the Tartars to have been of divine origin, ſince his family could be traced no farther back than ten generations, the mother of whom was got with child by a ſpirit. The names and tranſactions of his predeceſſors are equally uncertain and unimportant: he himſelf, however, was born in the year 1163, and is ſaid to have come into the world with congealed blood in his hands; from whence it was prognoſticated that he would be a great warrior, and obtain the victory over all his enemies.

This prediction, if any ſuch there was, Temujin moſt literally fulfilled. At the time of his father's deceaſe, his ſubjects amounted to between 30,000 and 40,000 families; but of theſe two thirds quickly deſerted, and Temujin was left almoſt without ſubjects. When only 13 years of age, he fought a bloody battle againſt theſe revolters; but either was defeated, or gained an indeciſive victory; ſo that he remained in obſcurity for 27 years longer. His good fortune at laſt he owed to the friendſhip of Vang Khan, who ruled over a great number of Tartar tribes to the north of Kitay, and has been heard of under the name of *Preſter John* among the Europeans. This prince took Temujin under his protection; and a rebellion being afterwards raiſed againſt himſelf, Temujin was made his general, and the khan was kept in poſſeſſion of his throne; ſoon after which, Temujin ſubdued the tribes which had revolted from himſelf, treating them at the ſame time with the utmoſt barbarity.

7 Subdues his revolted ſubjects by means of Vang Khan.

8 Who becomes jealous, and contrives his deſtruction.

This happened in the year 1201; but Vang Khan, inſtead of continuing the friend of Temujin, now became jealous, and reſolved to deſtroy him by treachery. With this view he propoſed a marriage between Temujin's ſon Juji and his own daughter, and another between Temujin's daughter and his own ſon. Temujin was invited to the camp of Vang Khan, in order to celebrate this double marriage; but, receiving intelligence of ſome evil intention againſt him, he excuſed himſelf to Vang Khan's meſſengers, and deſired that the ceremony might be put off to ſome other time.

A few days after the departure of theſe meſſengers, Badu and Kiſhlik, two brothers, who kept the horſes of one of Vang Khan's chief domeſtics, came and informed Temujin, that the grand Khan finding he had miſſed his aim, was reſolved to ſet out inſtantly, and ſurpriſe him next morning, before he could ſuſpect any danger. Temujin, alarmed at this intelligence, quitted his camp in the night-time, and retired with all his people to ſome diſtance. He was ſcarce gone, when Vang Khan's troops arrived, and diſcharged an incredible number of arrows among the empty tents; but finding nobody there, they purſued Temujin in ſuch haſte that they fell into great diſorder. In this condition they were ſuddenly attacked and routed by Temujin, after which an open war with Vang Khan took place.

9 Temujin overcomes all his enemies.

By this quarrel almoſt all the princes of Tartary were put in motion; ſome ſiding with Tamujin, and others with Vang Khan. But at laſt fortune declared in favour of the former: Vang Khan was overthrown in a battle, where he loſt 40,000 men; and obliged to fly for refuge to a prince named *Tayyan Khan*, who was Temujin's father-in-law, and his own enemy, and by whom he was ungenerouſly put to death. Temujin immediately began to ſeize on his dominions, great part of which voluntarily ſubmitted: but a confederacy was formed againſt him by a number of Vang Khan's tributaries, at the head of whom was Jamuka, a prince who had already diſtinguiſhed himſelf by his enmity to Temujin; and even Tayyan Khan himſelf was drawn into the plot, through jealouſy of his ſon-in-law's good fortune. But Temujin was well prepared; and in the year 1204 attacked Tayyan Khan, entirely routed his army, killed himſelf, and took Jemuka priſoner, whoſe head he cauſed inſtantly to be ſtruck off; after which he marched againſt the other tribes who had conſpired againſt him. Them he quickly reduced; took a city called *Kaſhin*, where he put all to the ſword who had borne arms againſt him; and reduced all the Mogul tribes in 1205.

Temujin now, having none to oppoſe him, called a general diet, which he appointed to be held on the firſt day of the ſpring 1206; that is, on the day in which the ſun entered Aries. To this diet were ſummoned all the great lords both Moguls and Tartars; and in the mean time, to eſtabliſh good order in the army, he divided his ſoldiers into bodies of 10,000, 1000, 100, and 10 men, with their reſpective officers, all ſubordinate to the generals, or thoſe who commanded the bodies of 10,000; and theſe were to act under his own ſons. On the day of holding the diet, the princes of the blood and great lords appeared dreſſed in white. Temujin, dreſſed in the ſame manner, with his crown on his head, ſat down on his throne, and was complimented by the whole aſſembly, who wiſhed him the continuance of his health and proſperity. After this they confirmed the Mogul empire to him and his ſucceſſors; adding all thoſe kingdoms which he had ſubdued, the deſcendents of whoſe vanquiſhed khans were deprived of all right or title to them; and after this he was proclaimed emperor with much ceremony. During this inauguration, a pretended prophet declared that he came from God to tell the aſſembly, that from thenceforth Temujin ſhould aſſume the name of *Jenghiz Khan*, or *the Moſt Great Khan of khans*; propheſying alſo, that all his poſterity ſhould be khans from generation to generation. This prophecy, which was no doubt owing to Temujin himſelf, had a ſurpriſing effect on his ſubjects, who from that time concluded, that all the world belonged of right to them, and even thought it a crime againſt heaven for any body to pretend to reſiſt them.

10 Aſſumes the title of Jenghiz Khan.

Jenghiz Khan having now reduced under his ſubjection all the wandering tribes of Moguls and Tartars, began to think of reducing thoſe countries to the ſouth

Mogul. south and south-west of his own, where the inhabitants were much more civilized than his own subjects; and the countries being full of fortified cities, he must of course expect to meet with more resistance. He began with the emperor of Hya, whose dominions he invaded in 1209, who at last submitted to become his tributary. But in the mean time Jenghiz Khan himself was supposed to be tributary to the emperor of Kitay; who, in 1210, sent him an officer, demanding the customary tribute. This was refused with the utmost indignation, and a war commenced, which ended not but with the dissolution of the empire of Kitay, as mentioned under the article CHINA, n° 17—33.

11 Invades, Hya, China, &c.

In the year 1216 Jenghiz Khan resolved to carry his arms westward, and therefore left his general Muchuli to pursue his conquests in Kitay. In his journey westward he overthrew an army of 300,000 Tartars who had revolted against him; and, in 1218, sent ambassadors desiring an alliance with Mohammed Karazm Shah, emperor of Gazna. His ambassador was haughtily treated: however, the alliance was concluded; but soon after broken, through the treachery, as it is said, of the Karazmian monarch's subjects. This brought on a war attended with the most dreadful devastations, and which ended with the entire destruction of the empire of Karazm or Gazna, as related under the article GAZNA.

After the reduction of Karazm, part of the Moguls broke into Iran or Persia, where also they made large conquests, while others of their armies invaded Georgia and the countries to the west; all this time committing such enormities, that the Chinese historians say, both men and spirits burst with indignation. In 1225, Jenghiz Khan returned to Hya, where he made war on the emperor for having sheltered some of his enemies. The event was, that the emperor was slain, and his kingdom conquered, or rather destroyed; which, however, was the last exploit of this most cruel conqueror, who died in 1227, as he marched to complete the destruction of the Chinese.

12 Vast extent of his empire.

The Mogul empire, at the death of Jenghiz Khan, extended over a prodigious tract of country; being more than 1800 leagues in length from east to west, and upwards of 1000 in breadth from north to south. Its princes, however, were still insatiable, and pushed on their conquests on all sides. Oktay was acknowledged emperor after Jenghiz Khan; and had under his immediate government Moguleſtan, (the country of the Moguls properly so called), Kitay, and the countries eastward to the Tartarian sea. Jagatay his brother governed under him a great part of the western conquests. The country of the Kipjacks, and others to the east and north-east, north and north-west, were governed by Batu or Patu the son of Juji, who had been killed in the wars; while Tuli or Toley, another son of Jenghiz Khan, had Khorassan, Persia, and what part of India was conquered. On the east side the Mogul arms were still attended with success; not only the empire of Kitay, but the southern part of CHINA, was conquered, as already related under that article, n° 23—40. On the west side matters continued much in the same way till the year 1254, when Magu, or Menkho, the fourth khan of the Moguls, (the same who was afterwards killed at a siege in China *), raised a great army, which he gave to his brother Hulaku, or Hulagu, to extend his dominions westward. In 1255 he entered Iran; where he suppressed the Ismaelians or Assassins, of whom an account is given under the article ASSASSINS; and two years afterwards he advanced to Bagdad, which he took, and cruelly put the khalif to death, treating the city with no more lenity than the Moguls usually treated those which fell into their hands. Every thing was put to fire and sword; and in the city and its neighbourhood, the number of slain, it is said, amounted to 1,600,000.—The next year he invaded Syria; the city of Damascus was delivered up, and, as it made no resistance, the inhabitants were spared; but Aleppo being taken by storm, a greater slaughter ensued there than had taken place at Bagdad, not even the children in their cradles being spared. Some cities of this country revolted the next year, or the year after; but falling again into the hands of the Moguls, they were plundered, and the inhabitants butchered without mercy, or carried into slavery.

* See *China*, n° 36.

13 Bagdad reduced.

Hulaku died in 1264, and at his death we may fix the greatest extent of the Mogul empire. It now comprehended the whole of the continent of Asia, excepting part of Indostan, Siam, Pegu, Cochinchina, and a few of the countries of Lesser Asia, which had not been attacked by them; and during all these vast conquests no Mogul army had ever been conquered, except one by Jaloloddin, as mentioned under the article GAZNA.—From this period, however, the empire began to decline. The ambition of the khans having prompted them to invade the kingdoms of Japan and Cochinchina, they were miserably disappointed in their attempts, and lost a great number of men.—The same bad success attended them in Indostan; and in a short time this mighty empire broke into several smaller ones. The governors of Persia being of the family of Jenghiz Khan, owned no allegiance to any superior; those of Tartary did the same. The Chinese threw off the yoke: and thus the continent of Asia wore much the same face that it had done before Jenghiz Khan began his conquests.

14 It begins to decline.

The successors of Hulaku reigned in Persia till the year 1335; but that year Abusaid Khan, the eighth from Hulaku, dying, the affairs of that country fell into confusion for want of a prince of the race of Jenghiz Khan to succeed to the throne. The empire therefore was divided among a great number of petty princes, who fought against each other almost without intermission, till, in the year 1369, Timur Bek, or Tamerlane, one of these princes, having conquered a number of others, was crowned at Balkh, with the pompous title of *Saheb Karan*; that is, "the emperor of the age, and conqueror of the world." As he had just before taken that city, and destroyed one of his most formidable rivals who had shut himself up in it, the new emperor began his reign with beheading some of the inhabitants, imprisoning others, burning their houses, and selling the women and children for slaves.—In 1370 he crossed the Sihun, made war on the Getes, and attacked Karazm. Next year he granted a peace to his enemies; but two years after, he again invaded the country of the Gates, and by the year 1379 had fully conquered that country as well as Korazan; and from that time he continued to extend his conquests in much the same manner as Jenghiz

15 Tamerlane crowned emperor of Balkh.

16 Becomes a great conqueror.

Mogul. Jenghiz Khan had done, though with lefs cruelty. In 1387 he had reduced Armenia, Georgia, and all Perfia; the conqueft of which laft was completed by the reduction of Ifpahan, 70,000 of the inhabitants of which were flaughtered on account of a fedition raifed by fome rafh or evil-difpofed perfons.

After the reduction of Perfia, Timur turned his arms northward, and weftward, fubduing all the countries to the Euphrates. He took the city of Bagdad; fubdued Syria; and having ravaged great part of Ruffia, returned to Perfia in 1396, where he fplendidly feafted his whole army. In 1398 he invaded Indoftan, croffed the Indus on the 17th of September, reduced feveral fortreffes, and made a vaft number of captives. However, as he was afraid that, in cafe of any emergency, thefe prifoners might take part with the enemy, he gave orders to his foldiers to put all their Indian flaves to death; and, in confequence of this inhuman order, more than 100,000 of thefe poor wretches were flaughtered in lefs than an hour.

17 Invades and conquers Indoftan.

In the beginning of the year 1399, Timur was met by the Indian army; whom, after a defperate battle, he defeated with great flaughter, and foon after took the city of Dehli, the capital of the country. Here he feated himfelf on the throne of the Indian emperors; and here the fharifs, kadis, and principal inhabitants of the city, came to make their fubmiffion, and begged for mercy. The tame elephants and rhinocerofes likewife were brought to kneel before him as they had been accuftomed to do to the Indian emperors, and made a great cry as if they implored his clemency. Thefe war-elephants, 120 in number, were, at his return, fent to Samarcand, and to the province where his fons refided. After this, at the requeft of the lords of the court, Timur made a great feaft; at which he diftributed prefents to the princes and principal officers.

18 The city of Dehli deftroyed, and the inhabitants flaughtered.

Dehli at this time confifted of three cities, called *Seyri*, *Old Dehli*, and *Jehan Penah*. Seyri was furrounded with a wall in form of a circle. Old Dehli was the fame, but much larger, lying fouth-weft of the other. Thefe two parts were joined on each fide by a wall; and the third, lying between them, was called *Jehan Penah*, which was larger than Old Dehli. Penah had ten gates; Seyri had feven, three of which looked towards Jehan Penah; this laft had thirteen gates, fix to the north-weft, and feven to the fouth-eaft. Every thing feemed to be in a quiet pofture; when, on the 12th of January 1399, the foldiers of Timur being affembled at one of the gates of Dehli, infulted the inhabitants of the fuburbs. The great emirs were ordered to put a ftop to thefe diforders; but their endeavours were not effectual. The foltanas having a curiofity to fee the rarities of Dehli, and particularly a famous palace adorned with 1000 pillars, built by an ancient king of India, went in with all the court; and the gate being on that occafion left open for every body, above 15,009 foldiers got in unperceived. But there was a far greater number of troops in a large place between Dehli, Seyri, and Jehan Penah, who committed great diforders in the two laft cities. This made the inhabitants in defpair fall on them; and many, fetting fire to their houfes, burnt their wives and children. The foldiers feeing this confufion, did nothing but pillage the houfes; while the diforder was increafed by the admiffion of more troops who feized the inhabitants of the neighbouring places, who had fled thither for fhelter. The emirs, to put a ftop to this mifchief, caufed the gates to be fhut: but they were quickly opened by the foldiers within, who rofe in arms againft their officers; fo that by the morning of the 13th the whole army was entered, and this great city was totally deftroyed. Some foldiers carried out 150 flaves, men, women, and children; nay, fome of their boys had 20 flaves a-piece to their fhare. The other fpoils, in jewels, plate, and manufactures, were immenfe; for the Indian women and girls were adorned with precious ftones, and had bracelets and rings on their hands, feet, and even toes, fo that the foldiers were loaded with them. On the 15th, in Old Dehli, the Indians retired into the great mofque to defend themfelves; but being attacked by the Tartars they were all flaughtered, and towers erected with their heads. A dreadful carnage now enfued throughout the whole city, and feveral days were employed before the inhabitants could be made to quit it entirely; and as they went, the emirs took a number of them for their fervice. The artifans were alfo diftributed among the princes and commanders; all but the mafons, who were referved for the emperor, in order to build him a fpacious ftone-mofque at Samarcand.

After this terrible devaftation, Timur marched into the different provinces of Indoftan, every where defeating the Indians who oppofed him, and flaughtering the Ghebrs, or worfhippers of fire. On the 25th of March he fet out on his return, and on the 9th of May arrived at Samarcand. In a few months after his arrival, he was obliged to undertake an expedition into Perfia, where affairs were in the utmoft diforder on account of the mifconduct of his fon, whom he had appointed fovereign of that empire. Here Timur foon fettled matters; after which he again fet out on an expedition weftward, reduced many places in Georgia which had not fubmitted before, and invaded and conquered Syria. At the fame time he quarrelled with Bajazet the Turkifh fultan, then bufied in an enterprife againft Conftantinople, in which he would probably have fucceeded had not Timur interpofed. The caufe of this quarrel at firft was, that Bajazet had demanded tribute from a prince who was under Timur's protection, and is faid to have returned an infulting anfwer to the Tartar ambaffadors who were fent to him on that account. Timur, however, who was an enthufiaft in the caufe of Mahometanifm, and confidered Bajazet as engaged in the caufe of heaven when befieging a Chriftian city, was very unwilling to difturb him in fo pious a work; and therefore undertook feveral expeditions againft the princes of Syria and Georgia, in order to give the Turkifh monarch time to cool and return to reafon. Among other places, he again invefted the city of Bagdad, which had caft off its allegiance to him; and having taken it by ftorm, made fuch a dreadful maffacre of the inhabitants, that 120 towers were erected with the heads of the flain. In the mean time Bajazet continued to give frefh provocation, by protecting one Kara Yufef a robber, who had even infulted the caravan of Mecca; fo that Timur at length refolved to make war upon him. The fultan, however, forefeeing the danger of

19 Timur quarrels with Bajazet the Turkifh fultan.

of bringing ſuch a formidable enemy againſt himſelf, thought proper to aſk pardon, by a letter, for what was paſt, and promiſe obedience to Timur's will for the future. This embaſſy was graciouſly received; and Timur returned for anſwer, that he would forbear hoſtilities, provided Bajazet would either put Kara Yuſef to death, ſend him to the Tartar camp, or expel him out of his dominions. Along with the Turkiſh ambaſſadors he ſent one of his own; telling Bajazet that he would march into the confines of Anatolia, and there wait his final anſwer.

Though Bajazet had ſeemed at firſt willing to come to an agreement with Timur, and to dread his ſuperior power; yet he now behaved in ſuch an unſatiſfactory manner, that the Tartar monarch deſired him to prepare for war; upon which he raiſed the ſiege of

20 Bajazet defeated and taken priſoner.

Conſtantinople, and having met Timur with an army greatly inferior to the Tartars, was utterly defeated and taken priſoner. According to ſome accounts, he was treated with great humanity and honour; while others inform us, that he was ſhut up in an iron cage, againſt which he daſhed out his brains the following year. At any rate, it is certain that he was not reſtored to liberty, but died in confinement.

This victory was followed by the ſubmiſſion of many places of the Leſſer Aſia to Timur; the Greek emperor owned himſelf his tributary, as did alſo the ſultan of Egypt. After this Timur once more returned to Georgia, which he cruelly ravaged; after which he marched to Samarcand, where he arrived in the year 1405. Here, being now an old man, this mighty conqueror began to look forward to that ſtate which at one time or other is the dread of all living creatures; and Timur, in order to quiet the remorſes of his own conſcience, came to the following curious reſolution, which he communicated to his intimate friends; namely, that "as the vaſt conqueſts he had made were not obtained without *ſome violence*, which had occaſioned the deſtruction of a great number of God's creatures, he was reſolved, by way of atonement for his paſt crimes, to perform ſome good action; namely, to make war on the infidels, and exter-

21 Death of Tamerlane, and diſſolution of his empire.

minate the idolaters of China." This atonement, however, he did not live to accompliſh; for he died the ſame year of a burning fever, in the 71ſt year of his age and 36th of his reign.

On the death of Timur, his empire fell immediately into great diſorder, and the civil wars continued for five or ſix years; but at laſt peace was reſtored, by the ſettlement of Shah Rukh, Timur's ſon, on the throne. He did not, however, enjoy the empire in its full extent, or indeed much above one half of it, having only Karazm, Khoraſſan, Kandahar, Perſia, and part of Indoſtan. Neither was he able, though a brave and warlike prince, to extend his dominions, though he tranſmitted them to his ſon Ulug Beg. He proved a wiſe and learned monarch; and is famous for the aſtronomical tables which he cauſed to be compoſed, and which are well known at this day. He was killed in 1448 by his ſon Abdollatif, who ſix months after was put to death by his own ſoldiers. After the death of Abdollatif, Abdollah, a grandſon of Shah Rukh, ſeized the throne; but, after reigning one year, was expelled by Abuſaid Mirza, the grandſon of Miran Shah the ſon of Timur. His reign was one continued ſcene of wars and tumults; till at laſt he was defeated and taken priſoner by one Haſſan Beg, who put him to death in 1468. From this time we may look upon the empire of Timur as entirely diſſolved, though his deſcendents ſtill reigned in Perſia and Indoſtan. The hiſtory of the latter, which is ſtill known by the name of the *Mogul's empire*, we ſhall now give from the death of Abuſaid Mirza to the preſent time. 22

History of Indoſtan.

On the death of the abovementioned monarch, his ſon Babr, or Babor, ſucceeded him, but was ſoon driven out by the Uſbeck Tartars; after which he reſided ſome time in Gazna, whence he made incurſions into Indoſtan, and at length became maſter of the whole empire, excepting the kingdoms of Dekan, Guzerat, and Bengal. He died in 1530, and was ſucceeded by his ſon Hemayun; who in the beginning of his reign conquered the province of Guzerat, excepting a very few places, and in 1540 made himſelf maſter of Bengal alſo; but ſoon after he was driven out of his dominions by the Afghans, a people inhabiting the mountainous country between India and Perſia. In this diſtreſs he fled to the court of Perſia; and being aſſiſted by that monarch, recovered his kingdom; but three months afterwards was killed by an accidental fall in the year 1556, the 26th of his reign.

Hemayun was ſucceeded by his ſon Akbar, at that time only 13 years of age. He ſubdued Guzerat, Bengal, and Kabul, (a country lying beyond the limits of India Proper), and conquered ſeveral other countries; but proved unſucceſsful in his attempts on Dekan. He poiſoned himſelf by miſtake in 1605, having ſwallowed the doſe he had cauſed to be prepared for one of his principal lords; and was ſucceeded by his ſon Jehan Ghir. The reign of this prince was full of troubles, owing chiefly to his own miſconduct. He invaded Dekan without ſucceſs, and was four years a priſoner in the hands of one of his generals named *Mohabet Khan;* from whom, however, he at laſt found means to eſcape, and enjoyed his empire till the year 1627, when he died, and was ſucceeded by his ſon Shah Jehan.

The new emperor proved a very debauched and avaricious prince; which gave occaſion to one of his ſons named *Aureng-zib*, or *Aureng-zebe*, to dethrone him. This prince attained his end by a train of deep hypocriſy and diſſimulation; covering his ambition with a pretence of religion, and under that pretence committing the greateſt crimes. He defeated two of his brothers who oppoſed him, by unforeſeen accidents, when he himſelf ſeemed to be on the very brink of deſtruction; and when he attained ſufficient power, put them to death, and then lamented their misfortune. One of his brothers who aſſiſted him, he rewarded with perpetual impriſonment, and at laſt put him to death alſo. The hiſtory of the empire, after he began to reign, is very much unknown, becauſe Aurengzebe would not allow it to be written during his life. Neither do we meet with any thing of importance regarding this empire till the invaſion of Thamas Kouli Khan, or Nadir Shah, emperor of Perſia, which happened in 1739. 23

The empire invaded by Nadir Shah.

This conqueror did not invade India, as Jenghiz Khan and Tamerlane had done, with a view to plunder; though, after he became maſter of Dehli, he

Mogul. ſeems not to have been inferior in rapacity to any of his predeceſſors. He was invited, however, by ſome of the great men who were diſaffected to the emperor Naſroddin Mohammed Shah, in order to ſettle the affairs of the empire. Nadir was eaſily induced to accept the invitation, and ſet out from Kandahar with an army of 125,000 men, compoſed of many different nations, and, being all inured to hardſhips, were much more than ſufficient to have conquered the whole force of the effeminate Indians. Accordingly he defeated the forces ſent againſt him; after which he was viſited by the Mogul himſelf. Him he ſeverely reprimanded for his miſconduct. However, he told him, that as he was of the race of Timur, who had not offended the reigning family of Perſia, he would not take the empire from him; only as he had put him to the trouble of coming ſo far to ſettle his affairs, he inſiſted that his expences ſhould be paid. To this ſpeech the Mogul made no anſwer; however, Nadir Shah took care to enforce the latter part of it. Some days after the Mogul's return, the Perſian monarch went to his camp to pay him a viſit, where he ſeized 200 cannon, with ſome treaſure and other effects, ſending them off immediately to Kandahar. He then marched to Dehli, where a dreadful ſlaughter was made, owing to a mob which aroſe about the price of corn. Nadir Shah, endeavouring to quell it, narrowly eſcaped being killed by a muſket-ball ſhot purpoſely at him; which enraged him to ſuch a degree, that he gave orders for an indiſcriminate maſſacre. Theſe orders were obeyed with the utmoſt alacrity by his ſoldiers; and 120,000, ſome ſay 150,000, of the inhabitants periſhed at once. After this all the jewels, gold-plate, &c. which could be found were ſeized, and the Shah demanded a preſent of money amounting to about 25 millions ſterling; which was raiſed with ſuch rigour, that many choſe to put an end to their own lives rather than bear the torments which were inflicted on thoſe who could not pay the ſum at which they were aſſeſſed. At laſt, however, the ſum was made up; and Nadir Shah took leave of the Mogul, with all the marks of friendſhip. He put the crown on his head with his own hands; and after having given him ſome good advice concerning the regulation and government of the empire, ſet out from Dehli on the 6th of May 1739.

24 Inhabitants of Dehli ſlaughtered.

By this invaſion the empire ſuſtained a prodigious loſs. Since the arrival of Shah Nadir in the country, about 200,000 people had been deſtroyed, and the conquerors had carried off treaſure and goods to the amount of 125 millions Sterling. Neverthleſs even this dreadful calamity did not awaken the ſufferers to a ſenſe of their danger, nor was any ſtep taken to put the empire in a proper ſtate of defence; ſo that it ſtill continues a prey to every invader, and equally incapable of ſubduing its enemies, or of defending itſelf.

25 Deſcription of Hindoſtan.

Hindoſtan, or the empire of the Great Mogul, or Mogol, is bounded on the north by Great and Little Tibet; on the eaſt by Tibet, and the Farther Peninſula of the Indies; on the ſouth by the Hither Peninſula, part of the Indian Sea, and Bay of Bengal; and on the weſt by Perſia. It is ſituated between the 84th and 102d degrees of longitude, and between the 21ſt and 36th degrees of latitude; being in length about 1204 miles, and in breadth 960, though in ſome parts not near ſo much. Mogul.

Towards the north, Hindoſtan is very cold and barren; but towards the ſouth, very hot, and fertile in corn, rice, fruits, and other vegetables. The northern provinces are very mountainous and ſandy; while the ſouthern are for the moſt part level, and well watered with ſeveral rivers.

The moſt remarkable mountains are thoſe which ſurround it on three ſides. Thoſe on the weſt, ſeparating it from Perſia, called, in general, *Soleyman Kûy*, or *the mountains of Soleyman*, are of a vaſt height as well as breadth, and are only paſſable in certain places, through which roads have been made for the ſake of commerce. The chief are thoſe which lead to Kabul, Gazna, and Kandahar. This great chain of mountains is inhabited by different nations, the principal of which are the Afghans, or Patans, and the Baluches, who have extended themſelves on the ſide of India, as well as Perſia. The mountains on the north are called *Nagrakut*, *Hima*, or *Mûs Tâg*, which has an affinity with *Imaüs*, and by other names, which are given alſo in common to the mountains on each ſide, ſeparating Hindoſtan from Tibet. The very proſpect of theſe mountains is frightful, being nothing but hideous precipices, perpetually covered with ſnow, and not to be croſſed without the greateſt danger and difficulty.

The moſt remarkable rivers of Hindoſtan are the Indus and Ganges. The former is called by the orientals *Send*, *Sind*, or *Sindi*. It riſes in the mountains to the north, or north-eaſt, of Hindoſtan; whence, after a long courſe, firſt to the ſouth and then to the ſouth-weſt, it falls into the Perſian ſea, below Lower Bander, by ſeveral mouths. In its courſe it receives ſeveral other large rivers, as the Nilâh, Jamal, Behat, and Lakka.

The Ganges, called in the Indies *Ganga*, riſes in the kingdom of Tibet: entering Hindoſtan, about the 30th degree of latitude, it runs firſt ſouth-eaſtward by the cities of Bekâner, Minapor, Halabas, Benâres, and Patna, to Rajah Mahl, where it divides into two branches. The eaſtern having paſſed by Dâkka, the capital of Bengal, enters the gulph of that name about Chatigan. The weſtern, deſcending by Koſſum-Bazar and Hughley, falls into the gulph below Shandernagor, towards Pipeli.

Many of the Jews and ancient Chriſtians believed this river to be the Piſon, one of the four mentioned in ſcripture as the boundaries of the terreſtrial pararadiſe. The Indians retain the greateſt reverence for its waters, going in crowds from the remoteſt parts of the country to waſh in them, from a perſuaſion that they deface from all the ſpots of ſin. The reaſon of this is, becauſe they imagine this river does not take its ſource from the boſom of the earth, but deſcends from heaven into the Paradiſe of Devendre, and from thence into Hindoſtan. Nothing is more childiſh than the fables of the Bramins on this ſubject, yet the people ſwallow them all. The Mogul and prince of Golconda drink no other water than that of the Ganges: foreigners, on the contrary, pretend that it is very unwholeſome, and that it cannot be ſafely drank till it is firſt boiled. There are a great number of ſuperb pagodas on the banks of the Ganges, which are im-

 immenfely rich. At certain feftivals, there has been fometimes a concourfe of 100,000 people who came to bathe in it. But what principally diftinguifhes this river, befides its greatnefs and rapidity, is the gold it brings down in its fands, and throws on its banks; and the precious ftones and pearls it produces, not only in itfelf, but in the Gulph of Bengal, into which it difcharges its waters, and which abound therewith. The Chun, or Jemma, the Guderafu, the Perfilis, Lakia, and feveral other rivers, difcharge themfelves into it during its courfe.

The weather and feafons are, for the general, very regular in this fpacious country; the winds blowing conftantly, for fix months, from the fouth, and fix from the north, with very little variation. The months of April, May, and the beginning of June, till the rains fall, are fo extremely hot, that the reflexion from the ground is apt to blifter one's face; and, but for the breeze, or fmall gale of wind, which blows every day, there would be no living in that country for people bred in northern climates; for, excepting in the rainy feafon, the coldeft day is hotter there at noon than the hotteft day in England. However, very furprifing changes of heat and cold fometimes happen within a few hours; fo that a ftifling hot day is fucceeded by a night cold enough to produce a thin ice on the water, and that night by a noon as fcorching as the preceding. Sometimes, in the dry feafon, before the rains, the winds blow with fuch extreme violence, that they carry vaft quantities of duft and fand into the air, which appear black, like clouds charged with rain; but fall down in dry fhowers, filling the eyes, ears, and noftrils of thofe among whom they defcend, and penetrate every cheft, cabinet, or cupboard, in the houfes or tents, by the key-hole or crevices.

From Surat to Agra, and beyond, it feldom or never rains, excepting in one feafon of the year; that is, from the middle of June to the middle of September. Thefe rains generally begin and end with moft furious ftorms of thunder and lightning. During thefe three months it rains ufually every day, and fometimes for a week together without intermiffion: by this means the land is enriched, like Egypt by the Nile. Although the land looks before like the barren fands of the Arabian defarts; yet, in a few days after thofe fhowers begin to fall, the furface appears covered with verdure. When the rainy feafon is over, the fky becomes perfectly ferene again, and fcarce one cloud appears all the nine months: however, a refrefhing dew falls every night, during that dry interval, which cools the air, and cherifhes the earth.

The produce of Hindoftan is very rich in every kind, whether it be foffil, vegetable, or animal. Befides other precious ftones found in it, there is a diamond-mine at the town of Soumelpûr, in Bengal. Quarries of Theban ftone are fo plentiful in the Mogul's empire, that there are both mofques and pagods built entirely of it. Some travellers tell us, there are mines of lead, iron, and copper, and even filver; but thofe of the laft, if there be any, need not be opened, fince the bullion of all nations is funk in this empire, which will take nothing elfe in exchange for her commodities, and prohibits the exporting it again. They till the ground with oxen and foot-ploughs, fowing in May and the beginning of June, that all may be over before the rains, and reaping in November and December, which with them is the moft temperate months in the year. The land is no where enclofed, excepting a little near towns and villages. The grafs is never mowed to make hay, but cut off the ground, either green or withered, as they have occafion to ufe it. Wheat, rice, barley, and other grain, grow here in plenty, and are very good. The country abounds no lefs in fruits, as pomegranates, citrons, dates, grapes, almonds, and cocoa-nuts; plums, thofe efpecially called *mirabolans*; plantanes, which in fhape refemble a flender cucumber, and in tafte excel a Norwich pear; mangos, an excellent fruit, refembling an apricot, but larger; ananas, or pine-apples; lemons and oranges, but not fo good as in other countries; variety of pears and apples in the northern parts; and the tamarind-tree, the fruit of which is contained in a pod refembling thofe of beans. There are many other kinds of fruit trees peculiar to the country. But the valuable trees are the cotton and mulberry, on account of the wealth they bring the natives from the manufactures of callicoes and filks. They plant abundance of fugar-canes here, as well as tobacco; but the latter is not fo rich and ftrong as that of America, for want of knowing how to cure and order it.

Hindoftan affords alfo plenty of ginger, together with carrots, potatoes, onions, garlic, and other roots known to us, befides fmall roots and herbs for fallads; but their flowers, though beautiful to look at, have no fcent, excepting rofes, and fome few other kinds.

There is a great variety of animals in this country, both wild and tame; of the former are elephants, rhinocerofes, lions, tygers, leopards, wolves, jackals, and the like. The jackalls dig up and eat dead bodies, and make a hideous noife in the night. The rhinoceros is not common in the Mogul's empire; but elephants are very numerous, fome 12, 14, or 15 feet high. There is plenty of venifon, and game of feveral kinds; as red-deer, fallow-deer, elks, antelopes, kids, hares, and fuch like. None of thefe are imparked, but all in common, and may be any body's who will be at the pains to take them. Among the wild animals alfo may be reckoned the mufk-animal, apes, and monkeys.

Hindoftan affords variety of beafts for carriage, as camels, dromedaries, mules, affes, horfes, oxen, and buffaloes. Moft of the horfes are white, and many curioufly dappled, pied, and fpotted all over. The flefh of the oxen is very fweet and tender. Being very tame, many ufe them as they do horfes, to ride on. Inftead of a bit, they put one or two fmall ftrings through the griftle of the noftrils, and faftening the ends to a rope, ufe it inftead of a bridle, which is held up by a bunch of grifly flefh which he has on the forepart of his back. They faddle him as they do a horfe; and, if fpurred a little, he will go as faft. Thefe are generally made ufe of all over the Indies; and with them only are drawn waggons, coaches, and chariots. Some of thefe oxen will travel 15 leagues in a day. They are of two forts; one fix feet high, which are rare; another called *dwarfs*, which are only three. In fome places, where the roads are ftony, they fhoe their oxen, when they are to travel far. The buffalo's fkin makes excellent

 excellent buff, and the female yields very good milk; but their flesh is neither so palatable nor wholesome as beef. The sheep of Hindostan have large heavy tails, and their flesh is very good, but their wool coarse.

This country is much infested with reptiles and insects; some of a noxious kind, as scorpions, snakes, and rats; but the lizards, which are of a green colour, are not hurtful. Snakes and serpents, we are told, are sometimes employed to dispatch criminals, especially such as have been guilty of some atrocious crime, that kind of death being attended with the most grievous torture. The most troublesome insects in this hot country are flies, musketoes, and chinches, or bugs, the first by day, and the others in the night, when they offend no less by their stench than their bite.

26 Account of the inhabitants.

Hindostan is inhabited by several different kinds of people, as the Hindoos, the Pâtans or Afghans, the Baluchis, the Parsis, and the Moguls or Tartars, besides foreigners, especially Jews and Christians of various sects. The Hindoos are the ancient inhabitants; and though subject to the Moguls, are at least some hundreds to one, compared with all the rest. The Parsis are the descendents of the ancient Persians, who worshipped the fire. These fled from India to avoid the persecution of the Mahometans; and are settled on the western peninsula, chiefly about Surat. The Patans, or Afghans, for they seem to be the same people under different names, are those from whom the Moguls conquered Hindostan. They are still very numerous; chiefly in the mountains and north-west parts, towards Kabul, Gazna, and Kandahar, from whence in all probability they originally came. They are a fierce and warlike people, and have a great aversion to the Moguls for having dispossessed them of their territories. The Baluchis, a barbarous people, and much given to rapine, possess several parts of Hindostan to the west of the Indus, particularly the province of Hajakhan. Both they and the Afghans also possess several parts of Persia. The Moguls, or Jagatays, are the present lords of Hindostan, where they reign over the rest, for the most part, with an absolute sway. Of these several nations, the Hindoos and Parsis are Pagan; but excel all the rest in modest deportment and the practice of virtue. The Patans, Baluchis, and Moguls, are Mahometans; and the first and last pretty strict observers of the laws and the rules of justice, at least among themselves. It is rare to see a crooked or deformed person, an idiot, or natural fool, in Hindostan. As to the complexion of the natives, they are of a deep tawny or olive colour; their hair jet black, but not curled. They like not people who are very white or fair, because that is the colour of lepers, who are common in those parts. Most of the Mahometans, except their priests and ancient men, keep their chins constantly shaven, but let the hair on their upper lip grow very long. They shave their heads all over, leaving only a lock on the crown, by which they expect to be drawn up to heaven by their prophet Mahomet. Instead of hats or bonnets, they wear a kind of turban, consisting of a piece of narrow calico, wound several times about the head. The inhabitants, in general, are very civil and courteous, as well to strangers as one another. They salute by bowing the head or their body, laying the right hand on their breast, and uttering compliments as they pass. The meaner people salute their superiors in a very submissive manner, either by putting the right hand to the ground, and then laying it on their head; or else by falling on their knees, and then bowing their head to the earth. In their more familiar salutations, they take each other by the chin, or beard, and cry *Baba*, "father," or *Bij*, "brother." The dress of the inhabitants of Hindostan is all the same in great and small, rich and poor, differing only in cost; for they never alter their fashions. Their upper-coats, to the waist, fit close to their bodies, whence they hang loose a little below their knees. Under this out-coat, they usually wear another slight one of the same cloth, but shorter, in the nature of a vest. Some of the richer sort, in the cooler parts of the day, slip on loose coats over the other, made of quilted silk, or callico, or else of English scarlet-cloth, for that is the colour they most affect. Under their coats they wear a sort of trowsers, which fall down to their ancles, and ruffle on the small of their legs: for their feet are always bare in their shoes, but as clean as their hands. They have girdles, made of a long piece of cloth, which go twice at least about them, the ends hanging down.

The dress of the Mahometan women differs but little from that of the men; only they bind their hair with long fillets, which hang down behind, and wear on their heads mantles or veils of calico; all round their ears they wear small pendants, made of thin and narrow pieces of gold or silver, brass or iron, according to the quality of the person. The lower part of their left nostril is also pierced for putting in rings of those metals at pleasure; the ends of their gold rings meeting in a pearl, drilled for that purpose. Some of the better sort wear great hollow rings of gold enamelled, silver, or brass, upon their wrists and the small of their legs, two or three on each limb, which makes a tinkling noise when they move.

Although the Mahometans are allowed four wives, very few, and those only of the richer sort, take more than one. They are so jealous, that they will not suffer either father or brother to speak to their wives, unless in their presence. Adultery and fornication are reckoned in the highest degree criminal. Great men have eunuchs to guard their women. Common prostitutes are tolerated here; but they must be licensed, before they are at liberty to open a house.

The women are exceeding happy in this part of the world in having easy labours; for it is common to see them one day riding big with child, and the next day riding again with the infants in their arms. The children of the poorer sort go naked several years, only now and then their mothers cover them with a slight calico mantle.

The Mahometans bury not in their mosques or churches, but in some open place out of town.

Their mourning over the deceased is immoderate, especially at their graves; when they often ask the party, as if living, Why he would die, since he had such loving wives and friends, and other comforts, in this life? The men of the greatest quality often provide fair sepulchres for themselves and friends. There are also many handsome monuments erected in memory of such as they esteem pirs, or saints; which are much resorted to by devout people, having lamps continually burning in them, with votaries, who have salaries to attend

attend them. The Mahometans beſtow not ſo much coſt on any ſort of ſtructures as on ſepulchres.

The common language of the empire, called the *Hindûſtân*, has a great affinity with the Perſian and Arabic, but is more ſmooth, and very ſignificant and conciſe. Its characters are different from thoſe of the above languages, and written from the left hand to the right, like the European. All the learning of the Moguls conſiſts in reading and writing; however, the people themſelves are men of very ſtrong reaſon, and will ſpeak off-hand on any ſubject exceeding well. Their chief ſtudy is aſtrology, with the belief of which the generality are ſtrangly infatuated; the Great Mogul himſelf undertaking nothing of any moment without conſulting his aſtrologers. For an account of the different religions in this empire, ſee the articles MAHOMETANISM and GENTOO; and HINDOO in the APPENDIX.

MOHAIR, in commerce, the hair of a kind of goat frequent about Angria in Turkey; the inhabitants of which city are all employed in the manufacture of camblets made of this hair.

MOHAWK COUNTRY, a part of North America, inhabited by one of the five nations of the Iroquois, ſituated between the province of New York and the lake Ontario or Frontignac.

MOHILA, or MOELIA, one of the Comorra iſlands in the Indian ſea, between the north end of the iſland of Madagaſcar and the continent of Africa. The inland parts are mountainous and woody; but the lands adjoining to the ſea are watered by ſeveral fine ſtreams which deſcend from the mountains; and the graſs is green all the year, ſo that it affords a moſt delightful habitation. There are plenty of proviſions of all kinds; and the Eaſt India ſhips of different nations ſometimes touch here for refreſhment.

MOHILOF, a large and ſtrong city of Poland, in the province of Lithuania, and palatinate of Mſciſlau. It is well built, populous, and has a conſiderable trade. Near this place the Swedes obtained a great victory over the Ruſſians in 1707.

MOIDORE, a Portugueſe gold coin, value 1l. 7s. Sterling.

MOIETY, the half of any thing.

MOLA, an ancient town of Italy, in the kingdom of Naples, and in the Terra di Lavoro, where they pretend to ſhew the ruins of Cicero's houſe. It is ſeated on the gulf of Venice, in E. Long. 17. 50. N. Lat. 41. 5.

MOLARES, or DENTES MOLARES, in anatomy, the large teeth, called in Engliſh the *grinders*. See ANATOMY, n° 26, l.

MOLDAVIA, a province of Turkey in Europe, bounded on the north-eaſt by the river Nieſter, which divides it from Poland; on the eaſt, by Beſſarabia; on the ſouth by the Danube, which parts it from Bulgaria; and on the weſt, by Walachia and Tranſilvania; it being 240 miles in length, and 150 in breadth. It lies in a good air and fruitful ſoil, producing corn, wine, rich paſtures, a good breed of horſes, oxen, ſheep, plenty of game, fiſh, fowl, honey, wax, and all European fruits. Its principal rivers are the Danube, Neiſter, Pruth, Bardalach, and Ceret. The inhabitants are Chriſtians of the Greek church, and Jaſſy is the principal town. It has been tributary to the Turks ever ſince the year 1574; who appoint a prince who is a native of the country, but have no regard to his being of the principal families. They pay a large yearly tribute; beſides which, they are obliged to raiſe a great body of horſe at their own expence.

MOLE, a river in Surry, which has taken its name from running under ground. It firſt diſappears at Box-hill, near Darking, in the county of Surry, and emerges again near Leatherhead.

MOLE, in zoology. See TALPA.

Moles in the fields may be deſtroyed by taking a head or two of garlic, onion, or leek, and putting it into their holes; on which they will run out as if frighted, and you may kill them with a ſpear or dog. Or pounded hellebore, white or black, with wheat-flour, the white of an egg, milk, and ſweet-wine, or metheglin, may be made into a paſte, and pellets as big as a ſmall nut may be put into their holes: the moles will eat this with pleaſure, and will be killed by it. In places where you would not dig nor break much, the fuming their holes with brimſtone, garlick, or other unſavoury things, drives them away; and if you put a dead mole into a common haunt, it will make them abſolutely forſake it.

Or take a mole-ſpear or ſtaff, and where you ſee them caſt, go lightly; but not on the ſide betwixt them and the wind, leſt they perceive you; and at the firſt or ſecond putting up of the earth, ſtrike them with your mole-ſtaff downright, and mark which way the earth falls moſt: if ſhe caſts towards the left-hand, ſtrike ſomewhat on the right-hand; and ſo on the contrary, to the caſting up of the plain ground, ſtrike down, and there let it remain; then take out the tongue in the ſtaff, and with the ſpattle, or flat edge, dig round about your grain to the end thereof, to ſee if you have killed her; and if you have miſſed her, leave open the hole, and ſtep aſide a little, and perhaps ſhe will come to ſtop the hole again, for they love but very little air; and then ſtrike her again; but if you miſs her, pour into the hole two gallons of water, and that will make her to come out for fear of drowning: mind them going out of a morning to feed, or coming home when fed, and you may take a great many.

MOLE, in midwifery, a maſs of fleſhy matter, of a ſpherical figure, generated in the uterus, and ſometimes miſtaken for a child. See MIDWIFERY, chap. ii.

MOLE, or *Mark*. See NÆVUS.

MOLE is alſo a maſſive work of large ſtones laid in the ſea by means of coffer-dams; extending before a port, either to defend the harbour from the impetuoſity of the waves, or to prevent the paſſage of ſhips without leave.

MOLE-*Cricket*. See GRYLLOTALPA.

MOLESWORTH (Robert), Viſcount Moleſworth, an eminent ſtateſman and polite writer, born at Dublin in 1656, where his father was a merchant. He was attainted by king James for his activity on the prince of Orange's invaſion; but the latter, when he was ſettled on the throne, called up Mr Moleſworth into the privy-council, and ſent him envoy-extraordinary to the court of Denmark. Here he reſided above three years, and then returned upon ſome diſguſt, without an audience of leave. Upon his return, he drew up his Account of Denmark, a work well known, in which

which he reprefented that government as arbitrary; and hence gave great offence to George prince of Denmark. The Danifh envoy prefented a memorial to king William concerning it; and then furnifhed materials for an anfwer, which was executed by Dr William King. Mr Molefworth was member of the houfes of commons in both kingdoms: king George I. made him a commiffioner of trade and plantations, and advanced him to the peerage of Ireland, by the title of *Baron Philipftown*, and *Vifcount Molefworth of Swords*. He died in 1725. Befide his Account of Denmark, he wrote an addrefs to the houfe of commons, for the encouragement of agriculture; and tranflated Franco Gallia, a Latin treatife of the civilian Hottoman, giving an account of the free ftate of France, and other parts of Europe, before the encroachments made on their liberties.

MOLIERE (John Baptift), a famous French comedian, whofe true name was *Pocquelin*, which for fome reafon or other he funk for that of Moliere. He was the fon of a valet de chambre, and was born at Paris about the year 1620. He went through the ftudy of the claffics under the Jefuits in the college of Clermont, and was defigned for the bar; but at his quitting the law-fchools, he made choice of the actor's profeffion. From the prodigious fondnefs he had for the drama, his whole ftudy and application being directed to the ftage, he continued till his death to exhibit plays, which were greatly applauded. It is faid the firft motive of his going upon the ftage was to enjoy the company of an actrefs, for whom he had contracted a violent fondnefs. His comedies are highly efteemed. And it is no wonder he fo juftly reprefented domeftic feuds, and the torments of jealous hufbands, or of thofe who have reafon to be fo, it being afferted that no man ever experienced all this more than Moliere, who was very unhappy in his wife. His laft comedy was *La Malade imaginaire*, which was brought on the ftage in 1673; and Moliere died on the fourth night of its reprefentation; fome fay in acting the very part of the pretended dead man, which gave fome exercife for the wits of the time; but according to others, he died in his bed that night, from the burfting of a vein in his lungs by coughing. The king, as a laft mark of his favour, prevailed with the archbifhop of Paris to fuffer him to be buried in confecrated ground; though he had irritated the clergy by his *Tartuffe*. The moft efteemed editions of his works are that of Amfterdam, 5 vols 12mo, 1699; and that of Paris, 6 vols 4to, 1734.

MOLINOS (Michael), a Spanifh prieft, who endeavoured to fpread new doctrines in Italy. He was born in the diocefe of Saragoffa in 1627; and entered into prieft's orders, though he never held any ecclefiaftical benefice. He was a man of good fenfe and learning, and his life was exemplary; though, inftead of practifing aufterities, he gave himfelf up to contemplation and myftical devotion. He wrote a book intitled, *Il Guida Spirituale*, containing his peculiar notions, which was greedily read both in Italy and Spain. His followers are called *Quietifts;* becaufe his chief principle was, that men ought to annihilate themfelves in order to be united to God, and afterwards remain in quietnefs of mind, without being troubled for what fhall happen to the body. He was taken up in 1687; and his 68 propofitions were examined by the pope and inquifitors, who decreed that his doctrine was falfe and pernicious, and that his books fhould be burned. He was forced to recant his errors publicly in the Dominicans church, and was condemned to perpetual imprifonment. He was 50 years old when he was taken, and had been fpreading his doctrine 22 years before. He died in prifon in 1692.

MOLOCH, a falfe god of the Ammonites, who dedicated their children to him, by making them "pafs through the fire," as the fcriptures exprefs it. There are various opinions concerning this method of confecration. Some think, the children leaped over a fire facred to Moloch; others, that they paffed between two fires; and others, that they were really burnt in the fire, by way of facrifice to this god. There is foundation for each of thefe opinions. For, firft, it was ufual among the pagans to luftrate or purify with fire; and, in the next place, it is exprefsly faid, that the inhabitants of Sepharvaim burnt their children in the fire to Anamalech and Adrammelech; much fuch deities as Moloch of the Ammonitess

Mofes, in feveral places, forbids the Ifraelites to dedicate their children to this god, as the Ammonites did, and threatens death and utter extirpation to fuch perfons as were guilty of this abominable idolatry. And there is great probability that the Hebrews were much addicted to the worfhip of this deity; fince Amos, and after him St Stephen, reproaches them with having carried along with them into the wildernefs the tabernacle of their god Moloch.

Solomon built a temple to Moloch upon the mount of Olives; and Manaffeh, a long time after, imitated his impiety, by making his fon pafs through the fire in honour of Moloch. It was chiefly in the valley of Tophet and Hinnom, to the eaft of Jerufalem, that the Ifraelites paid their idolatrous worfhip to this falfe god of the Ammonites.

There are various fentiments concerning the relation which Moloch had to the other pagan divinities. Some believe he was the fame with Saturn, to whom it is well known that human facrifices were offered. Others fuppofe him to be Mercury; others, Mars; others, Mithras; and others, Venus. Laftly, others take Moloch to be the fun, or the king of heaven. Moloch was likewife called *Milkom;* as appears from what is faid of Solomon, that he went after Afhtaroth the abomination of the Zidonians, and Milkom the abomination of the Ammonites.

MOLOSSES, in commerce, the thick fluid matter remaining after fugar is made, like fyrup. In Holland moloffes are much ufed in the manufacture of tobacco, and by the poor people for fugar. A brandy is alfo diftilled from them, but it is faid to be unwholefome.

MOLOSSUS, in Greek and Latin poetry, a foot compofed of three long fyllables; as *delectent*.

MOLTEN-GREASE, in farriery. See there § xviii.

MOLUCCA ISLANDS, lie in the Eaft Indian fea under the line; of which there are five principal, namely, Ternate, Tydor, Machian, Motyr, and Bacchian. The largeft of them are hardly 30 miles in circumference. They produce neither corn, rice, nor cattle, except goats: but they have oranges, lemons, and other fruits; and are moft remarkable for fpices, efpecially

cially cloves. They have large fnakes, which are not venomous, and very dangerous land crocodiles. At prefent they have three kings; and the Dutch, who are very ftrong there, keep out all other European nations, being jealous of their fpice-trade. The religion is idolatry; but there are many Mahometans. They were difcovered by the Portuguefe in 1511, who fettled upon the coaft; but the Dutch drove them away, and are now mafters of all thefe iflands.

MOLWITZ, a town of Silefia, in the province of Grotfka, remarkable for a battle gained by the Pruffians over the Auftrians in 1741. E. Long. 16. 45. N. Lat. 50. 26.

MOLYBDIA, in natural hiftory, the name of a genus of cryftals of a cubic form, or compofed of fix fides, at right angles, like a dye.

MOLYNEUX (William), an excellent mathematician and aftronomer, was born at Dublin in 1656, and admitted into the univerfity of that city; which when he left, he carried with him, a teftimonial drawn up in an uncommon form, and in the ftrongeft terms, fignifying the high opinion conceived of his genius, the probity of his manners, and the remarkable progrefs he had made in letters. In 1675, he entered in the middle-temple, where he fpent three years in the ftudy of the laws of his country: but the bent of his genius lay ftrongly toward mathematics and philofophical ftudies; and even at the univerfity he conceived a diflike to fcholaftic learning, and fell into the methods of Lord Bacon. In 1683, he formed a fociety in Dublin, for carrying on the fame defign with the royal fociety in London. He foon got a few ingenious men to meet at ftated times under proper regulations. Their number immediately increafed; Sir William Petty was their firft prefident, and Mr Molyneux their firft fecretary. Their fociety continued to meet till 1688, when the confufion of the times difperfed them. Mr Molyneux's reputation for learning recommended him, in 1684, to the notice and favour of the firft and great duke of Ormond, then lord-lieutenant of Ireland; and chiefly by his grace's influence he was appointed, that year, with Sir William Robinfon, furveyor-general of his majefty's buildings and works, and chief engineer. In 1686, he was fent abroad by the government to view the moft confiderable fortreffes in Flanders. He travelled, in company with Lord Mountjoy, through that country, Holland, part of Germany, and France. Upon his return from Paris to London, in April 1680, he publifhed his *Sciothericum Telefcopium*, containing a defcription of the ftructure and ufe of a telefcopial dial invented by him. The feverities of Tyrconnel's government forced him, with many others, into England, where he fpent two years with his family. In this retirement he wrote his Dioptrics, dedicated to the royal fociety. A parliament being called in Ireland under Lord Sidney in 1692, Mr Molyneux fat in it as one of the reprefentatives of the univerfity of Dublin. Upon the clofe of the feffion, the univerfity honoured him with the degree of doctor of laws; and by the lord-lieutenant he was appointed one of the commiffioners for the forfeitures in Ireland, with a falary of 500l. *per annum*. The laft favour he entirely declined, as engaging him in an invidious work. Not long before he died, he publifhed "The Cafe of Ireland ftated, in relation to its being bound by Acts of Parliament made in England." Among many perfons with whom he maintained correfpondence and friendfhip, Mr Locke was in a particular manner dear to him, as appears from their letters. In 1698, he made a journey to England on purpofe to pay a vifit to that great man; and not long after his return to Ireland was feized with a fit of the ftone, and died in 1698.—His fon, Samuel Molyneux Efq; was born in 1689, and became fecretary to George II. while prince of Wales, and one of the lords of the admiralty; in which place he died. He was a gentleman of great learning, efpecially in mathematical and philofophical fubjects.

MOMBAZA, or MONBAZA, a town of Africa, in an ifland of the fame name, with a caftle and a fort; feated on the eaftern coaft, oppofite to the country of Mombaza in Zanguebar, 70 miles fouth of Melinda, and fubject to Portugal. E. Long. 48. 0. N. Lat. 44. 0.

MOMBAZA, a country of Africa, in Zanguebar, fubject to the Portuguefe, from whence they export flaves, gold, ivory, rice, flefh, and other provifions, with which they fupply the fettlements in Brafil. The king of this country being a Chriftian, had a quarrel with the Portuguefe governor, took the caftle by affault, turned Mahometan, and murdered all the Chriftians in 1631; but in 1729 they became mafters of the territory again.

MOMENT, in the doctrine of time, an inftant, or the moft minute and indivifible part of duration.

MOMENTUM, in mechanics, fignifies the fame with impetus, or the quantity of motion in a moving body; which is always equal to the quantity of matter multiplied into the velocity; or, which is fame thing, it may be confidered as a rectangle under the quantity of matter and velocity.

MOMORDICA, MALE BALSAM APPLE; a genus of the fyngenefia order, belonging to the monœcia clafs of plants. The moft remarkable fpecies are, 1. The balfamina, or male balfam apple. This is a native of Afia; and hath a trailing ftalk like thofe of the cucumber or melon, with fmooth leaves, cut into feveral fegments, and fpread open like a hand. The fruit is oval, ending in acute points, having feveral deep angles, with fharp tubercles placed on their edges. It changes to a red or purplifh colour when ripe, opening with an elafticity, and throwing out its feeds. 2. The elaterium, wild or fpurting cucumber, hath a large flefhy root, fomewhat like briony, from whence come forth every fpring feveral thick, rough, trailing ftalks, dividing into many branches, and extending every way two or three feet; thefe are garnifhed with thick, rough, almoft heart-fhaped leaves, of a grey colour, ftanding upon long foot-ftalks. The flowers come out from the wings of the ftalks: thefe are male and female, growing at different places on the fame plant like thofe of the common cucumber; but they are much lefs, of a pale yellow colour, with a greenifh bottom; the male flowers ftand upon thick, fhort, foot-ftalks, but the female flowers fit upon the young fruit; which, after the flower is faded, grows of an oval form, an inch and a half long, fwelling like a cucumber, of a grey colour like the leaves, and covered over with fhort prickles. This fpecies has one of its names from the property of cafting out its feeds, together

gether with the viscid juice in which the seeds are lodged, with a violent force, if touched while ripe.

Uses. The first species is famous in Syria for curing wounds: the natives cut open the unripe fruit, and infuse it in sweet oil, which they expose to the sun for some days until it becomes red; and then present it for use. Dropped on cotton, and applied to a fresh wound, the Syrians reckon this oil the best vulnerary next to balsam of Mecca, having found by experience that it often cures large wounds in three days. The leaves and stems of this plant are used for arbours or bowers. The elaterium of the shops is the fruit, or rather the inspissated fæcula, of the juice of the unripe fruit of the wild cucumber. It is usually sent us from Spain and the southern parts of France, where the plant is common. We receive it in small, flat, whitish lumps, or cakes, that are dry, and break easily between the fingers. It is of an acrid, nauseous, bitter taste, and has a strong offensive smell when newly made; but these, as well as its other properties, it loses after being kept for some time. It is a very violent purge and vomit, and is now but seldom used. From the property which the plant has of throwing out its seeds, it has sometimes been called *Noli me tangere.*

MOMUS, in fabulous history, the god of raillery, or the jester of the celestial assembly, and who ridiculed both gods and men. Being chosen by Vulcan, Neptune, and Minerva, to give his judgment concerning their works, he blamed them all: Neptune for not making his bull with horns before his eyes, in order that he might give a surer blow; Minerva for building an house that could not be removed in case of bad neighbours; and Vulcan, for making a man without a window in his breast, that his treacheries might be seen.

MONA, two islands of this name in the sea lying between Britain and Ireland. The one described by Cæsar, as situated in the mid-passage between both islands, and stretching out in length from south to north. Called *Monaæda,* (Ptolemy); *Monapia,* or *Monabia,* (Pliny). Supposed to be the Isle of Man. Another Mona, (Tacitus); an island more to the south, and of greater breadth; situate on the coast of the Ordovices, from whom it is separated by a narrow strait. The ancient seat of the Druids. Now called *Anglesey,* the island of the Angles or English.

Mona, an island of the Baltic-Sea, south-west of the island of Zealand, subject to Denmark. E. Long. 12. 30. N. Lat. 55. 20.

MONADELPHIA, (from μονος "alone," and αδελφια a "brotherhood,") a single brotherhood; the name of the 16th class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers; in which all the stamina, or male organs of generation, are united below into one body or cylinder, through which passes the pointal or female organ. See Botany, p. 1296.

MONACO, a small, but handsome and strong town of Italy, in the territory of Genoa, with a castle, citadel, and a good harbour. It is seated on a craggy rock; and has its own prince, under the protection of France. E. Long. 7. 33. N. Lat. 43. 48.

MONAGHAN, a county of Ireland, in the province of Ulster, 32 miles long and 22 broad. It is bounded on the north by Tyrone; on the east by Armagh; on the south by Cavan and Louth; and on the west by Fermanagh. It is full of woods and bogs, and a third part of it is taken up by Lough Earne. It contains 24 parishes, five baronies, one borough, near 10,000 houses, and sends four members to parliament. Some time ago there were discovered on the borders of this county, four teeth of a prodigious magnitude, which the royal society, upon comparing with some teeth which had been found in England, were clearly of opinion could be no other that those of the elephant.

MONANDRIA, (from μονος "alone," and ανηρ a "man or husband;") the name of the first class in Linnæus's sexual system; consisting of plants with hermaphrodite flowers, which have only one stamen or male organ.

MONARCHY, a government in which the supreme power is vested in a single person. See Government.

MONARDA, Indian horehound; a genus of the monogynia order, belonging to the diandria class of plants. The most remarkable species is the zeylanica, a native of the East Indies. It rises with an herbaceous, four-cornered, hoary stalk; and bears leaves that are entire, nearly heart-shaped, woolly, deeply notched on the edges, and having foot-stalks. The flowers, which are purplish and fragrant, surround the stalk in whorls, each whorl containing about 14 flowers; and are succeeded by four small kidney-shaped shining seeds, lodged in the bottom of the permanent flower-cup. The Indians superstitiously believe that a fumigation of this plant is effectual for driving away the devil, and from this imaginary property its name in the Ceylonese language is derived. Grimmius relates, in his *Laboratorium Ceylonicum,* that for taste and smell this species of horehound stands remarkably distinguished. A water and subtile oil are obtained from it, both of which are greatly commended in obstructions of the matrix. A syrup is likewise prepared from this plant, which is useful in the above-mentioned disorders as well as in diseases of the stomach.

MONARDES (Nicholas), an excellent Spanish physician of Seville, who lived in the 16th century; and deservedly acquired great reputation by his practical skill and the books which he wrote. His Spanish works have been translated into Latin by Clusius; into Italian by Annibal Brigantus; and those upon American drugs have appeared in English. He died about the year 1578.

MONASTERY, a convent, or house built for the reception and entertainment of monks, mendicant friars, or nuns, whether it be an abbey, priory, &c.

Monasteries are governed by different rules, according to the different regulations prescribed by their founders. The first regular and perfect monasteries were founded by St Pachomius in Egypt: but St Basil is generally considered as the great father and patriarch of the eastern monks; since, in the fourth century, he prescribed rules for the government of the monasteries, to which the Anachorets and Cœnobites, and the other ancient fathers of the desarts, submitted. In like manner St Benedict was styled the *patriarch of the western monks.* He appeared in Italy towards the latter end of the fifth century, and published his rule, which was universally received throughout the west.

St Auguftine being fent into England by St Gregory the pope, in the year 596, to convert the Englifh, he at the fame time introduced the monaftic ftate into that kingdom; which made fuch progrefs there, that, within the fpace of 200 years, there were 30 kings and queens who preferred the religious habit to their crowns, and founded ftately monafteries, where they ended their days in retirement.

MONASTIC, fomething belonging to monks. See MONK.

MONCAON, or MONZON, a town of Portugal, in the province of Entre-Douro-de-Minho, with a ftrong caftle. The Spaniards have feveral times attempted to take it, but in vain. W. Long. 8. 2. N. Lat. 41. 52.

MONCON, or MONZON, a ftrong town of Spain, in the kingdom of Arragon. It was taken by the French in 1642, but the Spaniards retook it the following year. It is feated at the confluence of the rivers Sofa and Cinca. E. Long. 0. 19. N. Lat. 41. 43.

MONDOVI, a confiderable town of Italy, in Piedmont; with a citadel, univerfity, and bifhop's fee. It is the largeft and moft populous town of Piedmont, and is feated in E. Long. 8. 15. N. Lat. 44. 23.

MONDAY, the fecond day of the week, fo called as being anciently facred to the moon; *q. d.* moon-day.

MONEMUGI, an empire in the fouth of Africa, has Zanguebar on the eaft, Monotapa on the fouth, Motamba and Makoko on the weft, and Abyffinia on the north and partly to the eaft, tho' its boundaries that way cannot be afcertained. It is divided into the kingdoms of Mujaco, Makoko or Anfiko, Gingiro, Cambate, Alaba, and Monemugi Proper. This laft lies in the middle of the torrid zone, and about the equinoctial line fouth of Makoko, weft of Zanguebar, north of Monomotopa, and eaft of Congo and of the northern parts of Monomotopa. To afcertain its extent, is too difficult a tafk, being a country fo little frequented. The country known, abounds with gold, filver, copper mines, and elephants. The natives clothe themfelves in filks and cottons, which they buy of ftrangers, and wear collars of tranfparent amber-beads, brought them from Cambaya: which beads ferve alfo inftead of money; gold and filver being too common, and of little value among them.

Their monarch always endeavours to be at peace with the princes round about him, and to keep an open trade with Quitoa, Melinda, and Mombaza, on the eaft, and with Congo on the weft; from all which places the black merchants refort thither for gold. The Portuguefe merchants report, that on the eaft fide of Monemugi there is a great lake full of fmall iflands, abounding with all forts of fowl and cattle, and inhabited by negroes. They relate alfo, that on the main land eaftward they heard fometimes the ringing of bells, and that one could obferve buildings very much like churches; and that from thefe parts came men of a brown and tawny complexion, who traded with thofe iflanders, and with the people of Monemugi.

This country of Monemugi affords alfo abundance of palm-wine and oil, and fuch great plenty of honey, that above half of it is loft, the blacks not being able to confume it. The air is generally very unwholefome, and exceffively hot, which is the reafon why no Chriftians undertake to travel in this empire. De Lifle gives the divifion of this country as follows: The Maracates, the Meffeguaries, the kingdom of the Buengas, the kingdom of Mafti, and that of Maravi. But we are not acquainted with any particulars relating to thefe nations or kingdoms.

MONEY, a piece of matter, commonly metal, to which public authority has affixed a certain value and weight to ferve as a medium in commerce. See COIN, COMMERCE, and MEDALS.

Money is ufually divided into *real* or *effective*, and *imaginary* or *money of account*.

I. Real money includes all coins, or fpecies of gold, filver, copper, and the like; which have courfe in commerce, and do really exift. Such are guineas, piftoles, pieces of eight, ducats, &c.

Real money, civilians obferve, has three effential qualities, viz. matter, form, and weight or value.

For the matter, copper is that thought to have been firft coined; afterwards filver; and laftly gold, as being the moft beautiful, fcarce, cleanly, divifible, and pure of all metals.

The degrees of goodnefs are expreffed in gold by carats; and in filver by penny-weights, &c. For there are feveral reafons for not coining them pure and without alloy, viz. the great lofs and expence in refining them, the neceffity of hardening them to make them more durable, and the fcarcity of gold and filver in moft countries. See ALLOY.

Among the ancient Britons, iron rings, or, as fome fay, iron plates, were ufed for money; among the Lacedæmonians, iron bars quenched with vinegar, that they might not ferve for any other ufe. Seneca obferves, that there was anciently ftamped money of leather, *corium forma publica impreffum.* And the fame thing was put in practice by Frederic II. at the fiege of Milan; to fay nothing of an old tradition among ourfelves, that in the confufed times of the barons wars the like was done in England: but the Hollanders, we know, coined great quantities of pafteboard in the year 1574.

As to the form of money, it has been more various than the matter. Under this are comprehended the weight, figure, impreffion, and value.

For the impreffion, the Jews, tho' they detefted images, yet ftamped on the one fide of their fhekel the golden pot which had the manna, and on the other Aaron's rod. The Dardans ftamped two cocks fighting. The Athenians ftamped their coins with an owl, or an ox; whence the proverb on bribed lawyers, *Bos in lingua.* They of Ægina, with a tortoife; whence that other faying, *Virtutem & fapientiam vincunt teftudines.* Among the Romans, the monetarii fometimes impreffed the images of men that had been eminent in their families on the coins: but no living man's head was ever ftamped on a Roman coin till after the fall of the commonwealth. From that time they bore the emperor's head on one fide. From this time the practice of ftamping the prince's image on coins, has obtained among all civilized nations; the Turks and other Mahometans alone excepted, who, in deteftation of images, infcribe only the prince's name, with the year of the tranfmigration of their prophet.

As to the figure, it is either round, as in Britain; mul-

Money. multangular or irregular, as in Spain; ſquare, as in ſome parts of the Indies; or nearly globular, as in moſt of the reſt.

After the arrival of the Romans in this iſland, the Britons imitated them, coining both gold and ſilver with the images of their kings ſtamped on them. When the Romans had ſubdued the kings of the Britons, they alſo ſuppreſſed their coins, and brought in their own; which were current here from the time of Claudius to that of Valentinian the younger, about the ſpace of 500 years.

Mr Camden obſerves, that the moſt ancient Engliſh coin he had known was that of Ethelbert king of Kent, the firſt Chriſtian king in the iſland; in whoſe time all money-accounts begin to paſs by the names of *pounds*, *ſhillings*, *pence*, and *mancuſes*. Pence ſeems borrowed from the Latin *pecunia*, or rather from *pendo*, on account of its juſt weight, which was about three pence of our money. Theſe were coarſely ſtamped with the king's image on the one ſide, and either the mint-maſter's, or the city's where it was coined, on the other. Five of theſe pence made their ſcilling, probably ſo called from *ſcilingus*, which the Romans uſed for the fourth part of an ounce. Forty of theſe ſcillings made their pound; and 400 of theſe pounds were a legacy, or a portion for a king's daughter, as appears by the laſt will of king Alfred. By theſe names they tranſlated all ſums of money in their old Engliſh teſtament; talents by *pundes;* Judas's thirty pieces of ſilver by *thirtig ſcillinga;* tribute-money, by *penining;* the mite by *feorthling*.

But it muſt be obſerved, they had no other real money, but pence only; the reſt being imaginary moneys, *i. e.* names of numbers or weights. Thirty of theſe pence made a mancus, which ſome take to be the ſame with a mark; manca, as appears by an old MS. was *quinta pars unciæ*. Theſe mancas or mancuſes were reckoned both in gold and ſilver. For in the year 680, we read that Ina king of the Weſt Saxons obliged the Kentiſhmen to buy their peace at the price of 30,000 manca's of gold. In the notes on king Canute's laws, we find this diſtinction, that *mancuſa* was as much as a mark of ſilver; and *manca* a ſquare piece of gold, valued at 30 pence.

The Danes introduced a way of reckoning money by ores, *per oras*, mentioned in Domeſday-book; but whether they were a ſeveral coin, or a certain ſum, does not plainly appear. This, however, may be gathered from the Abbey-book of Burton, that 20 ores were equivalent to two marks. They had alſo a gold coin called *byzantine*, or *bezant*, as being coined at Conſtantinople, then called *Byzantium*. The value of which coin is not only now loſt, but was ſo entirely forgot even in the time of king Edward III. that whereas the biſhop of Norwich was fined a bizantine of gold to be paid the abbot of St Edmund's Bury for infringing his liberties (as it had been enacted by parliament in the time of the conqueror), no man then living could tell how much it was; ſo it was referred to the king to rate how much he ſhould pay. Which is the more unaccountable, becauſe but 100 years before, 200,000 bezants were exacted by the ſoldan for the ranſom of St Lewis of France; which were then valued at 100,000 livres.

Though the coining of money be a ſpecial prerogative of the king, yet the ancient Saxon princes communicated it to their ſubjects; inſomuch that in every good town there was at leaſt one mint; but at London eight, at Canterbury four for the king, two for the archbiſhop, one for the abbot at Wincheſter, ſix at Rocheſter, at Haſtings two, &c. Money.

The Norman kings continued the ſame cuſtom of coining only pence, with the prince's image on one ſide, and on the other the name of the city where it was coined, with a croſs ſo deeply impreſſed, that it might be eaſily parted and broke into two halves, which, ſo broken, they called *half-pence;* or into four parts, which they called *fourthings*, or *farthings*.

In the time of king Rich. I. money coined in the eaſt parts of Germany, came in ſpecial requeſt in England on account of its purity, and was called *eaſterling money*, as all the inhabitants of thoſe parts were called *Eaſterlings*. And ſhortly after, ſome of thoſe people ſkilled in coining were ſent for hither, to bring the coin to perfection; which ſince has been called *ſterling* for *Eaſterling*. See Sterling.

King Edward I. who firſt adjuſted the meaſure of an ell by the length of his arm, herein imitating Charles the Great, was the firſt alſo who eſtabliſhed a certain ſtandard for the coin, which is expreſſed to this effect by Greg. Rockley, mayor of London, and mint-maſter.—"A pound of money containeth twelve ounces: in a pound there ought to be eleven ounces, two eaſterlings, and one farthing; the reſt alloy. The ſaid pound ought to weigh twenty ſhillings and three pence in account and weight. The ounce ought to weigh twenty pence, and a penny twenty-four grains and a half. Note, that eleven ounces two-pence Sterling ought to be of pure ſilver, called *leaf-ſilver;* and the minter muſt add of other weight ſeventeen-pence halfpenny farthing, if the ſilver be ſo pure."

About the year 1320, the ſtates of Europe firſt began to coin gold; and among the reſt, our king Edward III. The firſt pieces he coined were called *florences*, as being coined by Florentines; afterwards he coined nobles; then roſe-nobles, current at 6*s.* and 8*d.*; half-nobles, called *half-pennies*, at 3*s.* and 4*d.* of gold; and quarters at 20*d.* called *farthings of gold*. The ſucceeding kings coined roſe-nobles, and double roſe-nobles, great ſovereigns, and half Henry nobles, angels, and ſhillings.

King James I. coined units, double crowns, Britain crowns: then crowns, half-crowns, &c.

II. *Imaginary* Money, or *Money of Account*, is that which has never exiſted, or at leaſt which does not exiſt in real ſpecies, but is a denomination invented or retained to facilitate the ſtating of accounts, by keeping them ſtill on a fixed footing, not to be changed, like current coins, which the authority of the ſovereign raiſes or lowers according to the exigencies of the ſtate. Of which kind are pounds, livres, marks, mar avedis, &c. See the annexed Table, where the fictitious money is diſtinguiſhed by a dagger (†).

Moneys of Account among the Ancients.—1. The Grecians reckoned their ſums of money by *drachmæ*, *minæ*, and *talenta*. The drachma was equal to $7\frac{3}{4}$ l. Sterling; 100 drachmæ made the mina, equal to 3*l.* 4*s.* 7*d.* Sterling; 60 mina made the talent, equal to

 to 193*l.* 15*s.* Sterling: hence 100 talents amounted to 19,375*l.* Sterling.

The mina and talentum, indeed, were different in different provinces: their proportions in Attic drachms are as follow. The Syrian mina contained 25 Attic drachms; the Ptolemaic $33\frac{1}{3}$; the Antiochic and Eubæan 100; the Babylonic 116; the greater Attic and Tyrian $133\frac{1}{3}$; the Æginean and Rhodian $166\frac{2}{3}$. The Syrian talent contained 15 Attic minæ; the Ptolemaic 20; the Antiochic 60; the Eubæan 60; the Babylonic 70; the greater Attic and Tyrian 80; the Æginean and Rhodian 100.

2. Roman moneys of account were the *feftertius* and *feftertium.* The feftertius was equal to 1*d.* $3\frac{3}{4}$*q.* Sterling. One thoufand of thefe made the feftertium, equal to 8*l.* 1*s.* 5*d.* 2*q.* Sterling. One thoufand of thefe feftertia made the decies feftertium (the adverb *centies* being always underftood) equal to 8072*l.* 18*s.* 4*d.* Sterling. The decies feftertium they alfo called *decies centena millia nummum.* Centies feftertium, or centies HS, were equal to 80,729*l.* 3*s.* 4*d.* Millies HS to 807,291*l.* 13*s.* 4*d.* Millies centies HS to 888,020*l.* 16*s.* 8*d.*

Theory of Money.

1. *Of Artificial or Material Money.*

I. As far back as our accounts of the tranfactions of mankind reach, we find they had adopted the precious metals, that is, filver and gold, as the common meafure of value, and as the adequate equivalent for every thing alienable.

The metals are admirably adapted for this purpofe: they are perfectly homogeneous: when pure, their maffes, or bulks, are exactly in proportion to their weights: no phyfical difference can be found between two pounds of gold, or filver, let them be the production of the mines of Europe, Afia, Africa, or America: they are perfectly malleable, fufible, and fuffer the moft exact divifion which human art is capable to give them: they are capable of being mixed with one another, as well as with metals of a bafer, that is, of a lefs homogeneous nature, fuch as copper: by this mixture they fpread themfelves uniformly through the whole mafs of the compofed lump, fo that every atom of it becomes proportionally poffeffed of a fhare of this noble mixture; by which means the fubdivifion of the precious metals is rendered very extenfive.

Their phyfical qualities are invariable: they lofe nothing by keeping; they are folid and durable; and tho' their parts are feparated by friction, like every other thing, yet ftill they are of the number of thofe which fuffer leaft by it.

If money, therefore, can be made of any thing, that is, if the proportional value of things vendible can be meafured by any thing material, it may be meafured by the metals.

II. The two metals being pitched upon as the moft proper fubftances for realifing the ideal fcale of money, thofe who undertake the operation of adjufting a ftandard, muft conftantly keep in their eye the nature and qualities of a fcale, as well as the principles upon which it is formed.

The unit of the fcale muft conftantly be the fame, altho' realifed in the metals, or the whole operation fails in the moft effential part. This realifing the unit is like adjufting a pair of compaffes to a geometrical fcale, where the fmalleft deviation from the exact opening once given muft occafion an incorrect meafure. The metals, therefore, are to money what a pair of compaffes is to a geometrical fcale.

This operation of adjufting the metals to the money of account implies an exact and determinate proportion of both metals to the money-unit, realifed in all the fpecies and denominations of coin, adjufted to that ftandard.

The fmalleft particle of either metal added to, or taken away from, any coins, which reprefent certain determinate parts of the fcale, overturns the whole fyftem of material money. And if, notwithftanding fuch variation, thefe coins continue to bear the fame denominations as before, this will as effectually deftroy their ufefulnefs in meafuring the value of things, as it would overturn the ufefulnefs of a pair of compaffes, to fuffer the opening to vary, after it is adjufted to the fcale reprefenting feet, toifes, miles, or leagues, by which the diftances upon the plan are to be meafured.

III. Debafing the ftandard is a good term; becaufe it conveys a clear and diftinct idea. It is diminifhing the weight of the pure metal contained in that denomination by which a nation reckons, and which we have called the *money-unit.* Raifing the ftandard requires no farther definition, being the direct contrary.

IV. Altering the ftandard (that is, raifing or debafing the value of the money-unit) is like altering the national meafures or weights. This is beft difcovered by comparing the thing altered with things of the fame nature which have fuffered no alteration. Thus if the foot of meafure was altered at once over all England, by adding to it, or taking from it, any proportional part of its ftandard length, the alteration would be beft difcovered by comparing the new foot with that of Paris, or of any other country, which had fuffered no alteration. Juft fo, if the pound Sterling, which is the Englifh unit, fhall be found any how changed, and if the variation it has met with be difficult to afcertain becaufe of a complication of circumftances, the beft way to difcover it, will be to compare the former and the prefent value of it with the money of other nations which has fuffered no variation. This the courfe of exchange will perform with the greateft exactnefs.

V. Artifts pretend, that the precious metals, when abfolutely pure from any mixture, are not of fufficient hardnefs to conftitute a folid and lafting coin. They are found alfo in the mines mixed with other metals of a bafer nature, and the bringing them to a ftate of perfect purity occafions an unneceffary expence. To avoid, therefore, the inconvenience of employing them in all their purity, people have adopted the expedient of mixing them with a determinate proportion of other metals, which hurts neither their fufibility, malleability, beauty, or luftre. This metal is called *alloy;* and, being confidered only as a fupport to the principal metal, is accounted of no value in itfelf. So that eleven ounces of gold, when mixed with one ounce of filver, acquires, by that addition, no augmentation of value whatever.

This

This being the cafe, we fhall, as much as poffible, overlook the exiftence of alloy, in fpeaking of money, in order to render language lefs fubject to ambiguity.

2. *Incapacities of the Metals to perform the Office of an invariable Meafure of Value.*

I. Were there but one fpecies of fuch a fubftance as we have reprefented gold and filver to be; were there but one metal poffeffing the qualities of purity, divifibility, and durability; the inconveniencies in the ufe of it for money would be fewer by far than they are found to be as matters ftand.

Such a metal might then, by an unlimited divifion into parts exactly equal, be made to ferve as a tolerably fteady and univerfal meafure. But the rivalfhip between the metals, and the perfect equality which is found between all their phyfical qualities, fo far as regards purity and divifibility, render them fo equally well adapted to ferve as the common meafure of value, that they are univerfally admitted to pafs current as money.

What is the confequence of this? that the one meafures the value of the other, as well as that of every other thing. Now the moment any meafure begins to be meafured by another, whofe proportion to it is not phyfically, perpetually, and invariably the fame, all the ufefulnefs of fuch a meafure is loft. An example will make this plain.

A foot of meafure is a determinate length. An Englifh foot may be compared with the Paris foot, or with that of the Rhine; that is to fay, it may be meafured by them: and the proportion between their lengths may be expreffed in numbers; which proportion will be the fame perpetually. The meafuring the one by the other will occafion no uncertainty; and we may fpeak of length by Paris feet, and be perfectly well underftood by others who are ufed to meafure by the Englifh foot, or by the foot of the Rhine.

But fuppofe that a youth of 12 years old takes it into his head to meafure from time to time, as he advances in age, by the length of his own foot, and that he divides this growing foot into inches and decimals: what can be learned from his account of meafures? As he increafes in years, his foot, inches, and fubdivifions, will be gradually lengthening; and were every man to follow his example, and meafure by his own foot, then the foot of a meafure now eftablifhed would totally ceafe to be of any utility.

This is juft the cafe with the two metals. There is no determinate invariable proportion between their value; and the confequence of this is, that when they are both taken for meafuring the value of other things, the things to be meafured, like lengths to be meafured by the young man's foot, without changing their relative proportion between themfelves, change, however, with refpect to the denominations of both their meafures. An example will make this plain.

Let us fuppofe an ox to be worth 3000 pounds weight of wheat, and the one and the other to be worth an ounce of gold, and an ounce of gold to be worth exactly 15 ounces of filver: if the cafe fhould happen, that the proportional value between gold and filver fhould come to be as 14 is to 1, would not the ox, and confequently the wheat, be eftimated at lefs in filver, and more in gold, than formerly? Farther, would it be in the power of any ftate to prevent this variation in the meafure of the value of oxen and wheat, without putting into the unit of their money lefs filver and more gold than formerly?

If therefore any particular ftate fhould fix the ftandard of the unit of their money to one fpecies of the metals, while in fact both the one and the other are actually employed in meafuring value; does not fuch a ftate refemble the young man who meafures all by his growing foot? For if filver, for example, be retained as the ftandard, while it is gaining upon gold one fifteenth additional value; and if gold continue all the while to determine the value of things as well as filver; it is plain, that, to all intents and purpofes, this filver-meafure is lengthening daily like the young man's foot, fince the fame weight of it muft become every day equivalent to more and more of the fame commodity; notwithftanding that we fuppofe the fame proportion to fubfift, without the leaft variation, between that commodity and every other fpecies of things alienable.

Buying and felling are purely conventional, and no man is obliged to to give his merchandife at what may be fuppofed to be the proportion of its worth. The ufe, therefore, of an univerfal meafure, is to mark, not only the relative value of the things to which it is applied as a meafure, but to difcover in an inftant the proportion between the value of thofe, and of every other commodity valued by a determinate meafure in all the countries of the world.

Were pounds Sterling, livres, florins, piaftres, &c. which are all money of account, invariable in their values, what a facility would it produce in all converfions, what an affiftance to trade! But as they are all limited or fixed to coins, and confequently vary from time to time, this example fhews the utility of the invariable meafure which we have defcribed.

There is another circumftance which incapacitates the metals from performing the office of money; the fubftance of which the coin is made, is a commodity which rifes and finks in its value with refpect to other commodities, according to the wants, competition, and caprices of mankind. The advantage, therefore, found in putting an intrinfic value into that fubftance which performs the function of money of account, is compenfated by the inftability of that intrinfic value; and the advantage obtained by the ftability of paper, or fymbolical money, is compenfated by the defect it commonly has of not being at all times fufceptible of realization into folid property or intrinfic value.

In order, therefore, to render material money more perfect, this quality of metal, that is, of a commodity, fhould be taken from it; and in order to render paper-money more perfect, it ought to be made to circulate upon metallic or land-fecurity.

II. There are feveral fmaller inconveniencies accompanying the ufe of the metals, which we fhall here fhortly enumerate.

1mo, No money made of gold or filver can circulate long, without lofing of its weight, altho' it all along preferves the fame denomination. This reprefents the contracting a pair of compaffes which had been rightly adjufted to the fcale.

2do, Ano-

2do, Another inconvenience proceeds from the fabrication of money. Suppofing the faith of princes who coin money to be inviolable, and the probity as well as capacity of thofe to whom they commit the infpection of the finenefs of the metals to be fufficient, it is hardly poffible for workmen to render every piece exactly of a proper weight, or to preferve the due proportion between pieces of different denominations; that is to fay, to make every ten fixpences exactly of the fame weight with every crown-piece and every five fhillings ftruck in a coinage. In proportion to fuch inaccuracies, the parts of the fcale become unequal.

3tio, Another inconvenience, and far from being inconfiderable, flows from the expence requifite for the coining of money. This expence adds to its value as a manufacture, withing adding any thing to its weight.

4to, The laft inconvenience is, that by fixing the money of account entirely to the coin, without having any independent common meafure, (to mark and control thefe deviations from mathematical exactnefs, which are either infeparable from the metals themfelves, or from the fabrication of them), the whole meafure of value, and all the relative interefts of debtors and creditors, become at the difpofal not only of workmen in the mint, of Jews who deal in money, of clippers and wafhers of coin; but they are alfo entirely at the mercy of princes, who have the right of coinage, and who have frequently alfo the right of raifing or debafing the ftandard of the coin, according as they find it moft for their prefent and temporary intereft.

3. *Methods which may be propofed for leffening the feveral Inconveniences to which Material Money is liable.*

The inconveniences from the variation in the relative value of the metals to one another, may in fome meafure be obviated by the following expedients.

1mo, By confidering one only as the ftandard, and leaving the other to feek its own value like any other commodity.

2do, By confidering one only as the ftandard, and fixing the value of the other from time to time by authority, according as the market-price of the metals fhall vary.

3tio, By fixing the ftandard of the unit according to the mean proportion of the metals, attaching it to neither; regulating the coin accordingly; and upon every confiderable variation in the proportion between them, either to make a new coinage, or to raife the denomination of one of the fpecies, and lower it in the other, in order to preferve the unit exactly in the mean proportion between the gold and filver.

4to, To have two units and two ftandards, one of gold and one of filver, and to allow every body to ftipulate in either.

5to, Or laft of all, to oblige all debtors to pay one half in gold, and one half in the filver ftandard.

4. *Variations to which the Value of the Money-unit is expofed from every Diforder in the Coin.*

Let us fuppofe, at prefent, the only diforder to confift in a want of the due proportion between the gold and filver in the coin.

This proportion can only be eftablifhed by the market-price of the metals; becaufe an augmentation and rife in the demand for gold or filver has the effect of augmenting the value of the metal demanded. Let us fuppofe, that to-day one pound of gold may buy fifteen pounds of filver: If to-morrow there be a high demand for filver, a competition among merchants to have filver for gold will enfue; they will contend who fhall get the filver at the rate of 15 pounds for one of gold: this will raife the price of it; and in proportion to their views of profit, fome will accept of lefs than the 15 pounds. This is plainly a rife in the filver, more properly than a fall in the gold; becaufe it is the competition for the filver which has occafioned the variation in the former proportion between the metals.

Let us now fuppofe, that a ftate, having with great exactnefs examined the proportion of the metals in the market, and having determined the precife quantity of each for realifing or reprefenting the money-unit, fhall execute a moft exact coinage of gold and filver coin. As long as that proportion continues unvaried in the market, no inconvenience can refult from that quarter in making ufe of metals for money of account.

But let us fuppofe the proportion to change; that the filver, for example, fhall rife in its value with regard to gold: will it not follow, from that moment, that the unit realized in the filver, will become of more value than the unite realized in the gold coin?

But as the law has ordered them to pafs as equivalents for one another, and as debtors have always the option of paying in what legal coin they think fit, will they not all choofe to pay in gold, and will not then the filver coin be melted down or exported, in order to be fold as bullion, above the value it bears when it circulates in coin? Will not this paying in gold alfo really diminifh the value of the money-unit, fince upon this variation every thing muft fell for more gold than before, as we have already obferved?

Confequently, merchandife, which have not varied in their relative value to any other thing but to gold and filver, muft be meafured by the mean proportion of the metals; and the application of any other meafure to them is altering the ftandard. If they are meafured by the gold, the ftandard is debafed; if by filver, it is raifed.

If, to prevent the inconvenience of melting down the filver, the ftate fhall give up affixing the value of their unit to both fpecies at once, and fhall fix it to one, leaving the other to feek its price as any other commodity; in that cafe, no doubt, the melting down of the coin will be prevented; but will ever this reftore the value of the money-unit to its former ftandard? Would it, for example, in the foregoing fuppofition, raife the debafed value of the money-unit in the gold coin, if that fpecies were declared to be the ftandard? It would indeed render filver coin purely a merchandife, and, by allowing it to feek its value, would certainly prevent it from being melted down as before; becaufe the pieces would rife conventionally in their denomination; or an *agio*, as it is called, would be taken in payments made in filver: but the gold would

would not, on that account, rise in its value, or begin to purchase any more merchandise than before. Were therefore the standard fixed to the gold, would not this be an arbitrary and a violent revolution in the value of the money-unit, and a debasement of the standard?

If, on the other hand, the state should fix the standard to the silver, which we suppose to have risen in its value, would that ever sink the advanced value which the silver coin had gained above the worth of the former standard unit? and would not this be a violent and an arbitrary revolution in the value of the money-unit, and a raising of the standard?

The only expedient, therefore, is, in such a case, to fix the numerary unit to neither of the metals, but to contrive a way to make it fluctuate in a mean proportion between them; which is in effect the introduction of a pure ideal money of account.

The regulation of fixing the unit by the mean proportion, ought to take place at the instant the standard unit is affixed with exactness both to the gold and silver. If it be introduced long after the market-proportion between the metals has deviated from the proportion established in the coin; and if the new regulation is made to have a retrospect, with regard to the acquitting of permanent contracts entered into while the value of the money-unit had attached itself to the lowest currency in consequence of the principle above laid down; then the restoring the money-unit to that standard where it ought to have remained (to wit, to the mean proportion) is an injury to all debtors who have contracted since the time that the proportion of the metals began to vary.

This is clear from the former reasoning. The moment the market-price of the metals differs from that in the coin, every one who has payments to make, pays in that species which is the highest rated in the coin; consequently, he who lends, lends in that species. If after the contract, therefore, the unit is carried up to the mean proportion, this must be a loss to him who had borrowed.

From this we may perceive, why there is less inconvenience from the varying of the proportion of the metals, where the standard is fixed to one of them, than when it is fixed to both. In the first case, it is at least uncertain whether the standard or the merchandise species is to rise; consequently it is uncertain whether the debtors or the creditors are to gain by a variation. If the standard species should rise, the creditors will gain; if the merchandise species rises, the debtors will gain; but when the unit is attached to both species, then the creditors never can gain, let the metals vary as they will: if silver rises, then debtors will pay in gold; if gold rises, the debtors will pay in silver. But whether the unit be attached to one or to both species, the infallible consequence of a variation is, that one half of the difference is either gained or lost by debtors and creditors. The invariable unit is constantly the mean proportional between the two measures.

5. *How the Variations of the intrinsic Value of the Unit of Money must affect all the domestic Interest of a Nation.*

If the changing the content of the bushel by which grain is measured, would affect the interest of those who are obliged to pay, or who are entitled to receive, a certain number of bushels of grain for the rent of lands; in the same manner must every variation in the value of the unit of account affect all persons who, in permanent contracts, are obliged to make payments, or who are entitled to receive sums of money stipulated in multiples or in fractions of that money-unit.

Every variation, therefore, upon the intrinsic value of the money-unit, has the effect of benefiting the class of creditors at the expence of debtors, or *vice versa*.

This consequence is deduced from an obvious principle. Money is more or less valuable in proportion as it can purchase more or less of every kind of merchandise. Now, without entering anew into the causes of the rise and fall of prices, it is agreed upon all hands, that whether an augmentation of the general mass of money in circulation has the effect of raising prices in general, or not, any augmentation of the quantity of the metals appointed to be put into the money-unit, must at least affect the value of that money-unit, and make it purchase more of any commodity than before: that is to say, if 113 grains of fine gold, the present weight of a pound Sterling in gold, can buy 113 pounds of flour; were the pound Sterling raised to 114 grains of the same metal, it would buy 114 pounds of flour; consequently, were the pound Sterling augmented by one grain of gold, every miller who paid a rent of ten pounds a-year, would be obliged to sell 1140 pounds of his flour, in order to procure ten pounds to pay his rent, in place of 1130 pounds of flour, which he sold formerly to procure the same sum; consequently, by this innovation, the miller must lose yearly ten pounds of flour, which his master consequently must gain. From this example, it is plain, that every augmentation of metals put into the pound Sterling, either of silver or gold, must imply an advantage to the whole class of creditors who are paid in pounds Sterling, and consequently must be a proportional loss to all debtors who must pay by the same denomination.

6. *Of the Disorder in the British Coin, so far as it occasions the melting down or the exporting of the Specie.*

The defects in the British coin are three.

1mo, The proportion between the gold and silver in it is found to be as 1 to $15\frac{2}{10}$, whereas the market price may be supposed to be nearly as 1 to $14\frac{1}{2}$.

2do, Great part of the current money is worn and light.

3tio, From the second defect proceeds the third, to wit, that there are several currencies in circulation which pass for the same value, without being of the same weight.

4to, From all these defects results the last and greatest inconvenience, to wit, that some innovation must be made, in order to set matters on a right footing.

The English, besides the unit of their money which they call the pound Sterling, have also the unit of their weight for weighing the precious metals.

This is called the *pound troy*, and consists of 12 ounces,

ounces, every ounce of 20 penny-weights, and every penny-weight of 24 grains. The pound troy, therefore, consists of 240 penny-weights, and 5760 grains.

The fineness of the silver is reckoned by the number of ounces and penny-weights of the pure metals in the pound troy of the composed mass; or, in other words, the pound troy, which contains 5760 grains of standard silver, contains 5328 grains of fine silver, and 432 grains of copper, called *alloy*.

Thus standard silver is 11 ounces 2 penny-weights of fine silver in the pound troy to 18 penny-weights copper, or 111 parts fine silver to 9 parts alloy.

Standard gold is 11 ounces fine to 1 ounce silver or copper employed for alloy, which together make the pound troy; consequently, the pound troy of standard gold contains 5280 grains fine, and 480 grains alloy, which alloy is reckoned of no value.

This pound of standard silver is ordered, by statute of the 43d of Elizabeth, to be coined into 62 shillings, 20 of which make the pound sterling; consequently the 20 shillings contain 1718.7 grains of fine silver, and 1858.06 standard silver.

The pound troy of standard gold, $\frac{11}{12}$ fine, is ordered, by an act of King Charles II. to be cut into 44½ guineas; that is to say, every guinea contains 129.43 grains of standard gold, and 118.644 of fine gold; and the pound Sterling, which is $\frac{20}{21}$ of the guinea, contains 112.994, which we may state at 113 grains of fine gold.

The coinage in England is entirely defrayed at the expence of the state. The mint price for the metals is the very same with the price of the coin. Whoever carries to the mint an ounce of standard silver, receives for it in silver coin 5*s.* 2*d.* or 62*d:* whoever carries an ounce of standard gold receives in gold coin 3*l.* 17*s.* 10½*d.* the one and the other making exactly an ounce of the same fineness with the bullion. Coin, therefore, can have no value in the market above bullion; consequently, no less can be incurred by those who melt it down.

When the guinea was first struck, the government (not inclining to fix the pound Sterling to the gold coin of the nation) fixed the guinea at 20 shillings, (which was then below its proportion to the silver), leaving it to seek its own price above that value, according to the course of the market.

By this regulation no harm was done to the English silver standard; because the guinea, or 118.644 grains fine gold being worth more, at that time, than 20 shillings, or 1718.7 grains fine silver, no debtor would pay with gold at its standard value; and whatever it was received for above that price was purely conventional.

Accordingly guineas sought their own price until the year 1728, that they were fixed a-new, not below their value as at first, but as what was then reckoned their exact value, according to the proportion of the metals, *viz.* at 21 shillings; and at this they were ordered to pass current in all payments.

This operation had the effect of making the gold a standard as well as the silver. Debtors then paid indifferently in gold as well as in silver, because both were supposed to be of the same intrinsic as well as current value; in which case no inconvenience could follow upon this regulation. But, in time, silver came to be more demanded; the making of plate began to prevail more than formerly, and the exportation of silver to the East Indies increasing yearly, made the demand for it greater, or perhaps brought its quantity to be proportionally less than before. This changed the proportion of the metals; and by slow degrees they have come from that of 1 to 15.2 (the proportion they were supposed to have when the guineas were fixed and made a lawful money at 21 shillings) to that of 14.5, the present *supposed* proportion.

The consequence of this has been, that the same guinea which was worth 1804.6 grains fine silver, at the time it was fixed at 21 shillings, is now worth no more than 1719.9 grains of fine silver according to the proportion of 14½ to 1.

Consequently debtors, who have always the option of the legal species in paying their debts, will pay pounds sterling no more in silver but in gold; and as the gold pounds they pay in, are not intrinsically worth the silver pounds they paid in formerly according to the statute of Elisabeth, it follows that the pound sterling in silver is really no more the standard, since nobody will pay at that rate, and since nobody can be compelled to do it.

Besides this want of proportion between the metals, the silver coined before the reign of George I. is now become light by circulation; and the guineas coined by all the princes since Charles II. pass by tale, tho' many of them are considerably diminished in their weight.

Let us now examine what profit the want of proportion and the want of weight in the coin can afford to the money-jobbers in melting it down or exporting it.

Did every body consider coin only as the measure for reckoning value, without attending to its value as a metal, the deviations of gold and silver coin from perfect exactness, either as to proportion or weight, would occasion little inconvenience.

Great numbers indeed, in every modern society, consider coin in no other light than that of money of account; and have great difficulty to comprehend what difference any one can find between a light shilling and a heavy one, or what inconvenience there can possibly result from a guinea's being some grains of fine gold too light to be worth 21 shillings standard weight. And did every one think in the same way, there would be no occasion for coin of the precious metals at all; leather, copper, iron, or paper, would keep the reckoning as well as gold and silver.

But although there be many who look no farther than at the stamp on the coin, there are others whose sole business it is to examine its intrinsic worth as a commodity, and to profit of every irregularity in the weight and proportion of metals.

By the very institution of coinage, it is implied, that every piece of the same metal, and same denomination with regard to the money-unit, shall pass current for the same value.

It is, therefore, the employment of money-jobbers, to examine, with a scrupulous exactness, the precise weight of every piece of coin which comes into their hands.

The first object of their attention is, the price of the metals in the market: a jobber finds, at present, that with 14.5 pounds of fine silver bullion, he can buy one

one pound of fine gold bullion.

He therefore buys up with gold coin all the new ſilver as faſt as it is coined, of which he can get at the rate of 15.2 pounds for one in gold; theſe 15.2 pounds ſilver coin he melts down into bullion, and converts that back into gold bullion, giving at the rate of only 14.5 pounds for one.

By this operation he remains with the value of $\frac{7}{10}$ of one pound weight of ſilver bullion clear profit upon the $15\frac{1}{2}$ pounds he bought; which $\frac{7}{10}$ is really loſt by the man who inadvertently coined ſilver at the mint, and gave it to the money-jobber for his gold. Thus the ſtate loſes the expence of the coinage, and the public the convenience of change for their guineas.

But here it may be aſked, Why ſhould the money-jobber melt down the ſilver coin? can he not buy gold with it as well without melting it down? He cannot; becauſe when it is in coin, he cannot avail himſelf of its being new and weighty. Coin goes by tale, not by weight; therefore, were he to come to market with his new ſilver coin, gold bullion being ſold at the mint price, we ſhall ſuppoſe, viz. at 3*l.* 17*s.* $10\frac{1}{2}$*d.* Sterling money *per* ounce, he would be obliged to pay the price of what he bought with heavy money, which he can equally do with light.

He therefore melts down the new ſilver coin, and ſells it for bullion, at ſo many pence an ounce; the price of which bullion is, in the Engliſh market, always above the price of ſilver at the mint, for the reaſons now to be given.

When you ſell ſtandard-ſilver bullion at the mint, you are to paid in weighty money; that is, you receive for your bullion the very ſame weight in ſtandard coin; the coinage coſt nothing: but when you ſell bullion in the market, you are paid in worn out ſilver, in gold, in bank-notes, in ſhort, in every ſpecies of lawful current money. Now all theſe payments have ſome defect: the ſilver you are paid with is worn and light; the gold you are paid with is over rated, and perhaps alſo light; and the bank-notes muſt have the ſame value with the ſpecie with which the bank pays them; that is, with light ſilver or over-rated gold.

It is for theſe reaſons, that ſilver bullion, which is bought by the mint at 5*s.* 2*d.* *per* ounce of heavy ſilver money, may be bought at market at 65 pence the ounce in light ſilver, over-rated gold, or bank-notes, which is the ſame thing.

Further, we have ſeen how the impoſition of coinage has the effect of raiſing coin above the value of bullion, by adding a value to it which it had not as a metal.

Juſt ſo, when the unit is once affixed to certain determined quantities of both metals, if one of the metals ſhould afterwards riſe in value in the market, the coin made of that metal muſt loſe a part of its value as coin, although it retains it as a metal. Conſequently, as in the firſt caſe it acquired an additional value by being coined, it muſt now acquire an addititional value by being melted down. From this we may conclude, that when the ſtandard is affixed to both the metals in the coin, and when the proportion of that value is not made to follow the price of the market, that ſpecies which riſes in the market is melted down, and the bullion is ſold for a price as much exceeding the mint price as the metal has riſen in its value.

If, therefore, in England, the price of ſilver bullion is found to be at 65 pence the ounce, while at the mint it is rated at 62; this proves that ſilver has riſen $\frac{3}{65}$ above the proportion obſerved in the coin, and that all coin of ſtandard weight may conſequently be melted down with a profit of $\frac{3}{65}$. But as there are ſeveral other circumſtances to be attended to which regulate and influence the price of bullion, we ſhall here paſs them in review, the better to diſcover the nature of this diſorder in the Engliſh coin, and the advantages which money-jobbers may draw from it.

The price of bullion, like that of every other merchandiſe, is regulated by the value of the money it is paid with.

If bullion, therefore, ſells in England for 65 pence an ounce, paid in ſilver coin, it muſt ſell for 65 ſhillings the pound troy; that is to ſay, the ſhillings it is commonly paid with do not exceed the weight of $\frac{1}{65}$ of a pound troy: for if the 65 ſhillings with which the pound of bullion is paid weighed more than a pound troy, it would be a ſhorter and better way for him who wants bullion to melt down the ſhillings and make uſe of the metal, than to go to market with them in order to get leſs.

We may, therefore, be very certain, that no man will buy ſilver bullion at 65 pence an ounce, with any ſhilling which weighs above $\frac{1}{65}$ of a pound troy,

We have gone upon the ſuppoſitiou that the ordinary price of bullion in the Engliſh market is 65 pence *per* ounce. This has been done upon the authority of ſome late writers on this ſubject: it is now proper to point out the cauſes which may make it deviate from that value.

I. It may vary, and certainly will vary, in the price, according as the currency is better or worſe. When the expences of a war, or a wrong balance of trade, have carried off a great many heavy guineas, it is natural that bullion ſhould riſe; becauſe then it will be paid for more commonly in light gold and ſilver; that is to ſay, with pounds Sterling, below the value of 113 grains fine gold, the worth of the pound Sterling in new guineas.

II. This wrong balance of trade, or a demand for bullion abroad, becoming very great, may occaſion a ſcarcity of the metals in the market, as well as a ſcarcity of the coin; conſequently, an advanced price muſt be given for it in proportion to the greatneſs and height of the demand. In this caſe, both the ſpecie and the bullion muſt be bought with paper. But the riſe in the price of bullion proceeds from the demand for the metals and the competition between merchants to procure them, and not becauſe the paper given as the price is at all of inferior value to the ſpecie. The leaſt diſcredit of this kind would not tend to diminiſh the value of the paper; it would annihilate it at once. Therefore, ſince the metals muſt be had, and that the paper cannot ſupply the want of them when they are to be exported, the price riſes in proportion to the difficulties in finding metals elſewhere than in the Engliſh market.

III. A ſudden call for bullion, for the making of plate. A goldſmith can well afford to give 67 pence for an ounce of ſilver, that is to ſay, he can afford to give one pound of gold for 14 pounds of ſilver, and perhaps for

for lefs, notwithftanding that what he gives be more than the ordinary proportion between the metals, becaufe he indemnifies himfelf amply by the price of his workmanfhip; juft as a tavern-keeper will pay any price for a fine fifh, becaufe, like the goldfmith, he buys for other people.

IV. The mint price has as great an effect in bringing down the price of bullion, as exchange has in raifing it. In countries where the metals in the coin are juftly proportioned, where all the currencies are of legal weight, and where coinage is impofed, the operations of trade make the price of bullion conftantly to fluctuate between the value of the coin and the mint-price of the metals.

Now let us fuppofe that the current price of filver bullion in the market is 65 pence the ounce, paid in lawful money, no matter of what weight or of what metal. Upon this the money-jobber falls to work. All fhillings which are above $\frac{1}{65}$ of a pound troy, he throws into his melting pot, and fells them as bullion for 65d. *per* ounce; all thofe which are below that weight he carries to market, and buys bullion with them at 65d. *per* ounce.

What is the confequence of this?

That thofe who fell the bullion, finding the fhillings which the money-jobber pays with perhaps not above $\frac{1}{66}$ of a pound troy, they on their fide raife the price of their bullion to 66 d. the ounce.

This makes new work for the money-jobber; for he muft always gain. He now weighs all fhillings as they come to hand; and as formerly he threw into his melting-pot thofe only which were worth more than $\frac{1}{65}$ of a pound troy, he now throws in all that are in value above $\frac{1}{66}$. He then fells the melted fhillings at 66 d. the ounce, and buys bullion with the light ones at the fame price.

This is the confequence of ever permitting any fpecies of coin to pafs by the authority of the ftamp, without controlling it at the fame time by the weight: and this is the manner in which money-jobbers gain by the currency of light money.

It is no argument againft this expofition of the matter to fay, that filver bullion is feldom bought with filver coin; becaufe the pence in new guineas are worth no more than the pence of fhillings of 65 in the pound troy: that is to fay, that 240 pence contained in $\frac{20}{21}$ of a new guinea, and 240 pence contained in 28 fhillings of 65 to the pound troy, differ no more in the intrinfic value than 0.83 of a grain of fine filver upon the whole, which is a mere trifle.

Whenever, therefore, fhillings come below the weight of $\frac{1}{65}$ of a pound troy, then there is an advantage in changing them for new guineas; and when that is the cafe, the new guineas will be melted down, and profit will be found in felling them for bullion, upon the principles we have juft been explaining.

We have already given a fpecimen of the domeftic operations of the money-jobbers; but thefe are not the moft prejudicial to national concerns. The jobbers may be fuppofed to be Englifhmen; and in that cafe the profit they make remains at home: but whenever there is a call for bullion to pay the balance of trade, it is evident that this will be paid in filver coin, never in gold, if heavy filver can be got; and this again carries away the filver coin, and renders it at home fo rare, that great inconveniencies are found for want of the leffer denominations of it. The lofs, however, here is confined to an inconvenience; becaufe the balance of trade being a debt which muft be paid, we do not confider the exportation of the filver for that purpofe as any confequence of the diforder of the coin. But befides this exportation which is neceffary, there are others which are arbitrary, and which are made only with a view to profit of the wrong proportion.

When the money-jobbers find difficulty in carrying on the traffic we have defcribed, in the Englifh market, becaufe of the competition among themfelves, they carry the filver coin out of the country, and fell it abroad for gold, upon the fame principles that the Eaft India company fend filver to China in order to purchafe gold.

It may be demanded, What hurt this trade can do to Britain, fince thofe who export filver bring back the fame value in gold? Were this trade carried on by natives, there would be no lofs; becaufe they would bring home gold for the whole intrinfic value of the filver. But if we fuppofe foreigners fending over gold to be coined at the Englifh mint, and changing the gold into Englifh filver coin, and then carrying off this coin, it is plain that they muft gain the difference, as well as the money-jobbers. But it may be anfwered, That having given gold for filver at the rate of the mint, they have given value for what they have received. Very right; but fo did Sir Hans Sloane, when he paid five guineas for an overgrown tod: he got value for his money; but it was value only to himfelf. Juft fo, whenever the Englifh government fhall be obliged to reftore the proportion of the metals, (as they muft do,) this operation will annihilate that imaginary value which they have hitherto fet upon gold; which imagination is the only thing which renders the exchange of their filver againft the foreign gold equal.

But it is farther objected, that foreigners cannot carry off the heavy filver; becaufe there is none to carry off. Very true; but then they have carried off a great quantity already: or if the Englifh Jews have been too fharp to allow fuch a profit to fall to ftrangers, (which may or may not have been the cafe,) then this diforder is an effectual ftop to any more coinage of filver for circulation.

7. *Of the Diforder in the Britifh Coin, fo far as it affects the Value of the Pound Sterling Currency.*

From what has been faid, it is evident, that there muft be found in England two legal pounds Sterling, of different values; the one worth 113 grains of fine gold, the other worth 1718.7 grains of fine filver. We call them different; becaufe thefe two portions of the precious metals are of different values all over Europe.

But befides thefe two different pounds Sterling, which the change in the proportion of the metals have created, the other defects of the circulating coin produce fimilar effects. The guineas coined by all the princes fince K. Charles II. have been of the fame ftandard weight and finenefs, $44\frac{1}{2}$ in a pound troy of ftandard gold $\frac{11}{12}$ fine: thefe have been conftantly

wearing ever ſince they have been coined; and in proportion to their wearing they are of leſs value.

If, therefore, the new guineas are below the value of a pound Sterling in ſilver, ſtandard weight, the old muſt be of leſs value ſtill. Here then is another currency, that is, another pound Sterling; or indeed, more properly ſpeaking, there are as many different pounds Sterling as there are guineas of different weights. This is not all; the money-jobbers having carried off all the weighty ſilver, that which is worn with uſe, and reduced even below the ſtandard of gold, forms one currency more, and totally deſtroys all determinate proportion between the money-unit and the currencies which are ſuppoſed to repreſent it.

It may be aſked, how, at this rate, any ſilver has remained in England? It is anſwered, that the few weighty ſhillings which ſtill remain in circulation, have marvellouſly eſcaped the hands of the money-jobbers: and as for the reſt, the rubbing and wearing of theſe pieces has done what the ſtate might have done; that is to ſay, it has reduced them to their due proportion with the lighteſt gold.

The diſorder, therefore, of the Engliſh coin has rendered the ſtandard of a pound Sterling quite uncertain. To ſay that it is 1718.7 grains of fine ſilver, is quite ideal. Who are paid in ſuch pounds? To ſay that it is 113 grains of pure gold, may alſo not be true; becauſe there are many currencies worſe than the new guineas.

What then is the conſequence of all this diſorder; What effect has it upon the current value of a pound Sterling? And which way can the value of that be determined?

The operations of trade bring value to an equation, notwithſtanding the greateſt irregularities poſſible; and ſo in fact a pound Sterling has acquired a determinate value over all the world by the means of foreign exchange. This is a kind of ideal ſcale for meaſuring the Britiſh coin, altho' it has not all the properties of that deſcribed above.

Exchange conſiders the pound Sterling as a value determined according to the combination of the values of all the different currencies, in proportion as payments are made in the one or the other; and as debtors generally take care to pay in the worſt ſpecies they can, it conſequently follows, that the value of the pound Sterling ſhould fall to that of the loweſt currency.

Were there a ſufficient quantity of worn gold and ſilver to acquit all bills of exchange, the pound Sterling would come down to the value of them; but if the new gold be alſo neceſſary for that purpoſe, the value of it muſt be proportionally greater.

All theſe combinations are liquidated and compenſated with one another, by the operations of trade and exchange: and the pound Sterling, which is ſo different in itſelf, becomes thereby, in the eyes of commerce, a determinate unit; ſubject, however, to variations, from which it never can be exempted.

Exchange, therefore, is one of the beſt meaſures for valuing a pound Sterling, preſent currency. Here occurs a queſtion:

Does the great quantity of paper-money in England tend to diminiſh the value of the pound Sterling?

We anſwer in the negative. Paper money is juſt as good as gold or ſilver money, and no better. The variation of the ſtandard, as we have already ſaid, muſt influence the intereſts of debtors and creditors proportionally every where. From this it follows, that all augmentation of the value of the money-unit in the ſpecie muſt hurt the debtors in the paper money; and all diminutions, on the other hand, muſt hurt the creditors in the paper money as well as every where elſe. The payments, therefore, made in paper money, never can contribute to the regulation of the ſtandard of the pound Sterling; it is the ſpecie received in liquidation of that paper money which alone can contribute to mark the value of the Britiſh unit; becauſe it is affixed to nothing elſe.

From this we may draw a principle, "That in countries where the money-unit is entirely affixed to the coin, the actual value of it is not according to the the legal ſtandard of that coin, but according to the mean proportion of the actual worth of thoſe currencies in which debts are paid.

From this we ſee the reaſon why the exchange between England and all other trading towns in Europe has long appeared ſo unfavourable. People calculate the real par, upon the ſuppoſition that a pound Sterling is worth 1718.7 grains troy of fine ſilver, when in fact the currency is not perhaps worth 1638, the value of a new guinea in ſilver, at the market proportion of 1 to 14.5; that is to ſay, the currency is but 95.3. *per cent.* of the ſilver ſtandard of the 43d of Eliſabeth. No wonder then if the exchange be thought unfavourable.

From the principle we have juſt laid down, we may gather a confirmation of what we advanced concerning the cauſe of the advanced price of bullion in the Engliſh market.

When people buy bullion with current money at a determinate price, that operation, in conjunction with the courſe of exchange, ought naturally to mark the actual value of the pound Sterling with great exactneſs.

If therefore the price of ſtandard bullion in the Engliſh market, when no demand is found for the exportation of the metals, that is to ſay, when paper is found for paper upon exchange, and when merchants verſed in theſe matters judge exchange (that is, remittances) to be at par, if then ſilver bullion cannot be brought at a lower price than 65 pence the ounce, it is evident that this bullion might be bought with 65 pence in ſhillings, of which 65 might be coined out of the pound troy Engliſh ſtandard ſilver; ſince 65 per ounce implies 65 ſhillings for the 12 ounces or pound troy.

This plainly ſhews how ſtandard ſilver bullion ſhould ſell for 65 pence the ounce, in a country where the ounce of ſtandard ſilver in the coin is worth no more than 62; and were the market-price of bullion to ſtand uniformly at 65 pence per ounce, that would ſhew the value of the pound Sterling to be tolerably fixed. All the heavy ſilver coin is now carried off; becauſe it was intrinſically worth more than the gold it paſſed for in curreucy. The ſilver therefore which remains is worn down to the market proportion of the metals,

Money. metals, as has been faid; that is to fay, 20 fhillings in filver currency are worth 113 grains of fine gold, at the proportion of 1 to 14.5 between gold and filver. Now,

as 1 is to 14.5, fo is 113 to 1638:

fo the 20 fhillings current weigh but 1638 grains fine filver, inftead of 1718.7, which they ought to do according to the ftandard.

Now let us fpeak of ftandard filver, fince we are examining how far the Englifh coin muft be worn by ufe.

The pound troy contains 5760 grains. This, according to the ftandard, is coined into 62 fhillings; confequently, every fhilling ought to weigh 92.9 grains. Of fuch fhillings it is impoffible that ever ftandard bullion fhould fell at above 62 pence *per* ounce. If therefore fuch bullion fells for 65 pence, the fhillings with which it is bought muft weigh no more than 88.64 grains ftandard filver; that is, they muft lofe 4.29 grains, and are reduced to $\frac{1}{65}$ of a pound troy.

But it is not neceffary that bullion be bought with fhillings; no ftipulation of price is ever made farther, than at fo many pence Sterling *per* ounce. Does not this virtually determine the value of fuch currency with regard to all the currencies in Europe? Did a Spaniard, a Frenchman, or a Dutchman, know the exact quantity of filver bullion which can be bought in the London market for a pound Sterling, would he inform himfelf any farther as to the intrinfic value of that money-unit; would he not underftand the value of it far better from that circumftance than by the courfe of any exchange, fince exchange does not mark the intrinfic value of money, but only the value of that money tranfported from one place to another?

The price of bullion, therefore, when it is not influenced by extraordinary demand, (fuch as for the payment of a balance of trade, or for making an extraordinary provifion of plate), but when it ftands at what every body knows to be meant by the common market price, is a very tolerable meafure of the value of the actual money-ftandard in any country.

If it be therefore true, that a pound Sterling cannot purchafe above 1638 grains of fine filver bullion, it will require not a little logic to prove that it is really, or has been for thefe many years, worth any more; notwithftanding that the ftandard weight of it in England is regulated by the laws of the kingdom at 1718.7 grains of fine filver.

If to this valuation of the pound Sterling drawn from the price of bullion, we add the other drawn from the courfe of exchange; and by this we find, that when paper is found for paper upon exchange, a pound Sterling cannot purchafe above 1638 grains of fine filver in any country in Europe: upon thefe two authorities we may very fafely conclude (as to the matter of fact at leaft) that the pound Sterling is not worth more, either in London or in any other trading city; and if this be the cafe, it is juft worth 20 fhillings of 65 to the pound troy.

If therefore the mint were to coin fhillings at that rate, and pay for filver bullion at the market price, that is, at the rate of 65 pence *per* ounce in thofe new coined fhillings, they would be in proportion to the gold; filver would be carried to the mint equally with gold, and would be as little fubject to be exported or melted down. Money.

It may be inquired in this place, how far the coining the pound troy into 65 fhillings is contrary to the laws of England?

The moment a ftate pronounces a certain quantity of gold to be worth a certain quantity of filver, and orders thefe refpective quantities of each metal to be received as equivalents of each other and as lawful money in payments, that moment gold is made a ftandard as much as filver. If therefore too fmall a quantity of gold be ordered or permitted to be confidered as an equivalent for the unit, the filver ftandard is from that moment debafed; or indeed, more properly fpeaking, all filver money is from that moment profcribed; for who, from that time, will ever pay in filver, when he can pay cheaper in gold? Gold, therefore, by fuch a law, is made the ftandard, and all declarations to the contrary are againft the matter of fact.

Were the king, therefore, to coin filver at 65 fhillings in the pound, it is demonftration, that by fuch an act he would commit no adulteration upon the ftandard: the adulteration is already committed. The ftandard has defcended to where it is by flow degrees, and by the operation of political caufes only; and nothing prevents it from falling lower but the ftandard of the gold coin. Let guineas be now left to feek their value as they did formerly, and let light filver continue to go by tale, we fhall fee the guineas up at 30 fhillings in 20 years time, as was the cafe in 1695.

It is as abfurd to fay that the ftandard of Queen Elizabeth has not been debafed by enacting that the Englifh unit fhall be acquitted with 113 grains of fine gold, as it would be to affirm that it would not be debafed from what it is at prefent by enacting that a pound of butter fhould every where be received in payment for a pound Sterling; although the pound Sterling fhould continue to confift of 3 ounces, 17 pennyweights, and 10 grains of ftandard filver, according to the ftatute of the 43d of Elizabeth. In that cafe moft debtors would pay in butter, and filver would, as at prefent, acquire a conventional value as a metal, but would be looked upon no longer as a ftandard, or as money.

If therefore, by the law of England, a pound Sterling muft confift of 1718.7 grains troy of fine filver; by the law of England alfo, 113 grains of gold muft be of the fame value: but no law can eftablifh that proportion; confequently, in which ever way a reformation be brought about, fome law muft be reverfed; confequently, expediency, and not compliance with law, muft be the motive in reforming the abufe.

From what has been faid, it is not at all furprifing that the pound Sterling fhould in fact be reduced nearly to the value of the gold. Whether it ought to be kept at that value is another queftion. All that we here decide, is, that coining the pound troy into 65 fhillings would reftore the proportion of the metals, and render both fpecies common in circulation. But reftoring the weight and proportion of the coin is not the difficulty which prevents a reformation of the Englifh coinage.

8. *Cir-*

8. *Circumftances to be attended to in a new Regulation of the Britifh Coin.*

To people who do not underftand the nature of fuch operations, it may have an air of juftice to fupport the unit at what is commonly believed to be the ftandard of Queen Elizabeth, *viz.* at 1718.7 grains of fine filver.

The regulating the ftandard of both filver and gold to $\frac{11}{12}$ fine, and the pound Sterling to four ounces ftandard filver, as it ftood during the reign of Queen Mary I. has alfo its advantages, as Mr Harris has obferved. It makes the crown-piece to weigh juft one ounce, the fhilling four penny-weight, and the penny eight grains; confequently, were the new ftatute to bear, that the weight of the coin fhould regulate its currency upon certain occafions, the having the pieces adjufted to certain aliquot parts of weight would make weighing eafy, and would accuftom the common people to judge of the value of money by its weight, and not by the ftamp.

In that cafe, there might be a conveniency in ftriking the gold coins of the fame weight with the filver; becaufe the proportion of their values would then conftantly be the fame with the proportion of the metals. The gold crowns would be worth at prefent, 3*l.* 12*s.* 6*d.* the half crowns 1*l.* 16*s.* 3*d.* the gold fhillings 14*s.* and 6*d.* and the half 7*s.* and 3*d.* This was anciently the practice in the Spanifh mints.

The interefts within the ftate can be nowife perfectly protected but by permitting converfions of value from the old to the new ftandard, whatever it be, and by regulating the footing of fuch converfions by act of parliament, according to circumftances.

For this purpofe, we fhall examine thofe interefts which will chiefly merit the attention of government, when they form a regulation for the future of acquitting permanent contracts already entered into. Such as may be contracted afterwards will naturally follow the new ftandard.

The landed intereft is, no doubt, the moft confiderable in the nation. Let us therefore examine, in the firft place, what regulations it may be proper to make, in order to do juftice to this great clafs, with refpect to the land-tax on one hand, and with refpect to their leffees on the other.

The valuation of the lands of England was made many years ago, and reafonably ought to be fupported at the real value of the pound Sterling at that time, according to the principles already laid down. The general valuation, therefore, of the whole kingdom will rife according to this fcheme. This will be confidered as an injuftice; and no doubt it would be fo, if, for the future, the land-tax be impofed as heretofore, without attending to this circumftance; but as that impofition is annual, as it is laid on by the landed-intereft itfelf, who compofe the parliament, it is to be fuppofed that this great clafs will at leaft take care of their own intereft.

Were the valuation of the lands to be ftated according to the valuation of the pound Sterling of 1718.7 grains of filver, which is commonly fuppofed to be the ftandard of Elizabeth, there would be no great injury done: this would raife the valuation only 5 *per cent.* and the land-tax in proportion.

There is no clafs of inhabitants in all England fo much at their eafe, and fo free from taxes, as the clafs of farmers. By living in the country, and by confuming the fruits of the earth without their fuffering any alienation, they avoid the effect of many excifes, which, by thofe who live in corporations, are felt upon many articles of their confumption, as well as on thofe which are immediately loaded with thefe impofitions. For this reafon it will not, perhaps, appear unreafonable, if the additional 5 *per cent.* on the land-tax were thrown upon this clafs, and not upon the landlords.

With refpect to leafes, it may be obferved, that we have gone upon the fuppofition that the pound Sterling in the year 1728, was worth 1718.7 grains of fine filver, and 113 grains of fine gold.

There would be no injuftice done the leffees of all the lands in the kingdom, were their rents to be fixed at the mean proportion of thefe values. We have obferved how the pound Sterling has been gradually diminifhing in its worth from that time by the gradual rife of the filver. This mean proportion, therefore, will nearly anfwer to what the value of the pound Sterling was in 1743; fuppofing the rife of the filver to have been uniform.

It may be farther alleged in favour of the landlords, that the gradual debafement of the ftandard has been more prejudicial to their intereft in letting their lands, than to the farmers in difpofing of the fruits of them. Proprietors cannot fo eafily raife their rents upon new leafes, as farmers can raife the prices of their grain according to the debafement of the value of the currency.

The pound Sterling, thus regulated at the mean proportion of its worth, as it ftands at prefent, and as it ftood in 1728, may be realized in 1678.6 grains of fine filver, and 115.76 grains fine gold: which is 2.4 *per cent.* above the value of the prefent currency. No injury, therefore, would be done to leffees, and no unreafonable gain would accrue to the landed intereft, in appointing converfions of all land-rents at $2\frac{1}{2}$ *per cent.* above the value of the prefent currency.

Without a thorough knowledge of every circumftance relating to Great Britain, it is impoffible to lay down any plan. It is fufficient here briefly to point out the principles upon which it muft be regulated.

The next intereft to be confidered is that of the nation's creditors. The right regulation of their concerns will have a confiderable influence in eftablifhing public credit upon a folid bafis, by making it appear to all the world, that no political operation upon the money of Great Britain can in any refpect either benefit or prejudice the intereft of thofe who lend their money upon the faith of the nation. The regulating alfo the intereft of fo great a body, will ferve as a rule for all creditors who are in the fame circumftances, and will, upon other accounts, be productive of greater advantages to the nation in time coming.

In 1749, a new regulation was made with the public creditors, when the intereft of the whole redeemable national debt was reduced to 3 *per cent.* This circumftance infinitely facilitates the matter with refpect to this clafs, fince, by this innovation of all former contracts, the whole national debt may be confidered as contracted at, or pofterior to, the 25th of December 1749.

Were

Were the ftate, by any arbitrary operation upon money, (which every reformation muft be), to diminifh the value of the pound Sterling in which the parliament at that time bound the nation to acquit thofe capitals and the intereft upon them, would not all Europe fay, That the Britifh parliament had defrauded their creditors? If therefore the operation propofed to be performed fhould have a contrary tendency, *viz.* to augment the value of the pound Sterling with which the parliament at that time bound the nation to acquit thofe capitals and interefts, muft not all Europe alfo agree, That the Britifh parliament had defrauded the nation?

This convention with the ancient creditors of the ftate, who, in confequence of the debafement of the ftandard, might have juftly claimed an indemnification for the lofs upon their capitals, lent at a time when the pound Sterling was at the value of the heavy filver, removes all caufe of complaint from that quarter. There was in the year 1749 an innovation in all their contracts; and they are now to be confidered as creditors only from the 25th of December of that year.

Let the value of the pound Sterling be inquired into during one year preceding and one pofterior to the tranfaction of the month of December 1749. The great fums borrowed and paid back by the nation during that period, will furnifh data fufficient for that calculation. Let this value of the pound be fpecified in troy grains of fine filver and fine gold bullion, without mentioning any denomination of money according to the exact proportion of the metals at that time. And let this pound be called the *pound of national credit.*

This firft operation being determined, let it be enacted, that the pound Sterling, by which the ftate is to borrow for the future, and that in which the creditors are to be paid, fhall be the exact mean proportion between the quantities of gold and filver above fpecified, according to the actual proportion of the metals at the time fuch payments fhall be made: or that the fums fhall be borrowed or acquitted, one half in gold and one half in filver, at the refpective requifitions of the creditors or of the ftate, when borrowing. All debts contracted pofterior to 1749 may be made liable to converfions.

The confequence of this regulation will be the infenfible eftablifhment of a bank-money. Nothing would be more difficult to eftablifh, by a pofitive revolution, than fuch an invariable meafure; and nothing will be found fo eafy as to let it eftablifh itfelf by its own advantages. This bank-money will be liable to much fewer inconveniencies than that of Amfterdam. There the perfons tranfacting muft be upon the fpot; here, the Sterling currency may, every quarter of a year, be adjufted by the exchequer to this invariable ftandard, for the benefit of all debtors and creditors, who incline to profit of the ftability of this meafure of value.

This fcheme is liable to no inconvenience from the variation of the metals, let them be ever fo frequent, or hard to be determined; becaufe upon every occafion where there is the fmalleft doubt as to the actual proportion, the option competent to creditors to be paid half in filver and half in gold will remove.

Such a regulation will alfo have this good effect, that it will give the nation more juft ideas of the nature of money, and confequently of the influence it ought to have upon prices.

If the value of the pound Sterling fhall be found to have been by accident lefs in December 1749 than it is at prefent; or if at prefent the currency be found below what has commonly been fince 1749; in juftice to the creditors, and to prevent all complaints, the nation may grant them the mean proportion of the value of the pound fterling from 1749 to 1760, or any other which may to parliament appear reafonable.

This regulation muft appear equitable in the eyes of all Europe; and the ftrongeft proof of it will be, that it will not produce the fmalleft effect prejudicial to the intereft of the foreign creditors. The courfe of exchange with regard to them will ftand precifely as before.

A Dutch, French, or German creditor, will receive the fame value for his intereft in the Englifh ftocks as heretofore. This muft filence all clamours at home, being the moft convincing proof, that the new regulation of the coin will have made no alteration upon the real value of any man's property, let him be debtor or creditor.

The intereft of every other denomination of creditors, whofe contracts are of a frefh date, may be regulated upon the fame principles. But where debts are of an old ftanding, juftice demands, that attention be had to the value of money at the time of contracting. Nothing but the ftability of the Englifh coin, when compared with that of other nations, can make fuch a propofal appear extraordinary. Nothing is better known in France than this ftipulation added to obligations, *Argent au cours de ce jour;* that is to fay, That the fum fhall be repaid in coin of the fame intrinfic value with what has been lent. Why fhould fuch a claufe be thought reafonable for guarding people againft arbitrary operations upon the numerary value of the coin, and not be found juft upon every occafion where the numerary value of it is found to be changed, let the caufe be what it will?

The next intereft we fhall examine is that of trade. When men have attained the age of 21, they have no more occafion for guardians. This may be applied to traders: they can parry with their pen every inconvenience which may refult to other people from the changes upon money, provided only the laws permit them to do themfelves juftice with refpect to their engagements. This clafs demands no more than a right to convert all reciprocal obligations into denominations of coin of the fame intrinfic value with thofe they have contracted in.

The next intereft is that of buyers and fellers; that is, of manufacturers with regard to confumers, and of fervants with refpect to thofe who hire their perfonal fervice.

The intereft of this clafs requires a moft particular attention. They muft, literally fpeaking, be put to fchool, and taught the firft principles of their trade, which is buying and felling. They muft learn to judge of price by the grains of filver and gold they receive: they are children of a mercantile mother, however warlike the father's difpofition. If it be the intereft of the ftate that their bodies be rendered robuft and active, it

Money. it is no leſs the intereſt of the ſtate that their minds be inſtructed in the firſt principles of the trade they exerciſe.

For this purpoſe, tables of converſion from the old ſtandard to the new muſt be made, and ordered to be put up in every market, in every ſhop. All duties, all exciſes, muſt be converted in the ſame manner. Uniformity muſt be made to appear every where. The ſmalleſt deviation from this will be a ſtumbling-block to the multitude.

Not only the intereſt of the individuals of the claſs we are at preſent conſidering, demands the nation's care and attention in this particular; but the proſperity of trade, and the well-being of the nation, are alſo deeply intereſted in the execution.

The whole delicacy of the intricate combinations of commerce depends upon a juſt and equable vibration of prices, according as circumſtances demand it. The more therefore the induſtrious claſſes are inſtructed in the principles which influence prices, the more eaſily will the machine move. A workman then learns to ſink his price without regret, and can raiſe it without avidity. When principles are not underſtood, prices cannot gently fall, they muſt be pulled down; and merchants dare not ſuffer them to riſe, for fear of abuſe, even although the perfection of an infant-manufacture ſhould require it.

The laſt intereſt is that of the bank of England, which naturally muſt regulate that of every other.

Had this great company followed the example of other banks, and eſtabliſhed a bank-money of an invariable ſtandard as the meaſure of all their debts and credits, they would not have been liable to any inconvenience upon a variation of the ſtandard.

The bank of England was projected about the year 1694, at a time when the current money of the nation was in the greateſt diſorder, and government in the greateſt diſtreſs both for money and for credit. Commerce was then at a very low ebb; and the only, or at leaſt the moſt profitable, trade of any, was jobbing in coin, and carrying backwards and forwards the precious metals from Holland to England. Merchants profited alſo greatly from the effects which the utter diſorder of the coin produced upon the price of merchandiſe.

At ſuch a juncture the reſolution was taken to make a new coinage; and upon the proſpect of this, a company was found, who, for an excluſive charter to hold a bank for 13 years, willingly lent the government upwards of a million Sterling at 8 *per cent.* (in light money we ſuppoſe), with a proſpect of being repaid both intereſt and capital in heavy. This was not all: part of the money lent was to be applied for the eſtabliſhment of the bank; and no leſs than 4000l. a-year was allowed to the company, above the full intereſt, for defraying the charge of the management.

Under ſuch circumſtances the introduction of bank-money was very ſuperfluous, and would have been very impolitic. That invention is calculated againſt the raiſing of the ſtandard: but here the bank profited of that riſe in its quality of creditor for money lent; and took care not to commence debtor by circulating their paper, until the effect of the new regulation took place in 1695; that is, after the general re-coinage of all the clipped ſilver.

From that time till now, the bank of England has been the baſis of the nation's credit, and with great reaſon has been conſtantly under the moſt intimate protection of every miniſter. Money.

The value of the pound Sterling, as we have ſeen, has been declining ever ſince the year 1601, the ſtandard being fixed to ſilver during all that century, while the gold was conſtantly riſing. No ſooner had the proportion taken another turn, and ſilver begun to riſe, than the government of England threw the ſtandard virtually upon the gold, by regulating the value of the guineas at the exact proportion of the market. By theſe operations, however, the bank has conſtantly been a gainer (in its quality of debtor) upon all the paper in circulation; and therefore has loſt nothing by not having eſtabliſhed a bank-money.

The intereſt of this great company being eſtabliſhed upon the principles we have endeavoured to explain, it is very evident, that the government of England never will take any ſtep in the reformation of the coin which in its conſequences can prove hurtful to the bank. Such a ſtep would be contrary both to juſtice and to common ſenſe. To make a regulation which, by raiſing the ſtandard, will prove beneficial to the public creditors, to the prejudice of the bank, (which we may call the *public debtor)* would be an operation upon public credit, like that of a perſon who is at great pains to ſupport his houſe by props upon all ſides, and who at the ſame time blows up the foundation of it with gunpowder.

We may therefore conclude, that with regard to the bank of England, as well as every other private banker, the notes which are conſtantly payable upon demand muſt be made liable to a converſion at the actual value of the pound Sterling at the time of the new regulation.

That the bank will gain by this, is very certain; but the circulation of their notes is ſo ſwift, that it would be abſurd to allow to the then poſſeſſors of them that indemnification which naturally ſhould be ſhared by all thoſe through whoſe hands they have paſſed, in proportion to the debaſement of the ſtandard during the time of their reſpective poſſeſſion.

Beſides theſe conſiderations, which are in common to all ſtates, the government of Great Britain has one peculiar to itſelf. The intereſt of the bank, and that of the creditors, are diametrically oppoſite: every thing which raiſes the ſtandard, hurts the bank; every thing which can ſink it, hurts the creditors: and upon the right management of the one and the other, depends the ſolidity of public credit. For theſe reaſons, without the moſt certain proſpect of conducting a reſtitution of the ſtandard to the general advantage as well as approbation of the nation, no miniſter will probably ever undertake ſo dangerous an operation.

We ſhall now propoſe an expedient which may remove at leaſt ſome of the inconveniencies which would reſult from ſo extenſive an undertaking as that of regulating the reſpective intereſts in Great Britain by a poſitive law, upon a change in the value of their money of account.

Suppoſe then, that, before any change is made in the coin, government ſhould enter into a tranſaction with the public creditors, and aſcertain a permanent value

value for the pound ſterling for the future, ſpecified in a determined proportion of the fine metals in common bullion, without any regard to money of account, or to any coin whatever.

This preliminary ſtep being taken, let the intended alteration of the ſtandard be proclaimed a certain time before it is to commence. Let the nature of the change be clearly explained, and let all ſuch as are engaged in contracts which are diſſolvable at will upon the preſtations ſtipulated, be acquitted between the parties, or innovated as they ſhall think proper; with certification, that, poſterior to a certain day, the ſtipulations formerly entered into ſhall be binding according to the denominations of the money of account in the new ſtandard.

As to permanent contracts, which cannot at once be fulfilled and diſſolved, ſuch as leaſes, the parliament may either preſcribe the methods and terms of converſion; or a liberty may be given to the parties to annul the contract, upon the debtor's refuſing to perform his agreement according to the new ſtandard. Contracts, on the other hand, might remain ſtable, with reſpect to creditors who would be ſatisfied with payments made on the footing of the old ſtandard. If the riſe intended ſhould not be very conſiderable, no great injuſtice can follow ſuch a regulation.

Annuities are now thoroughly underſtood, and the value of them is brought to ſo nice a calculation, that nothing will be eaſier than to regulate theſe upon the footing of the value paid for them, or of the ſubject affected by them. If by the regulation, land-rents are made to riſe in denomination, the annuities charged upon them ought to riſe in proportion; if in intrinſic value, the annuity ſhould remain as it was.

9. *Regulations which the Principles of this Inquiry point out as expedient to be made by a new Statute for regulating the Britiſh Coin.*

Let us now examine what regulations it may be proper to make by a new ſtatute concerning the coin of Great Britain, in order to preſerve always the ſame exact value of the pound Sterling realized in gold and in ſilver, in ſpite of all the incapacities inherent in the metals to perform the functions of an invariable ſcale or meaſure of value.

1. The firſt point is to determine the exact number of grains of fine gold and fine ſilver which are to compoſe it, according to the then proportion of the metals in the London market.

2. To determine the proportion of theſe metals with the pound troy; and in regard that the ſtandard of gold and ſilver is different, let the mint price of both metals be regulated according to the pound troy fine.

3. To fix the mint-price within certain limits; that is to ſay, to leave to the king and council, by proclamation, to carry the mint price of bullion up to the value of the coin, as is the preſent regulation, or to ſink it to *per cent.* below that price, according as government ſhall incline to impoſe a duty upon coinage.

4. To order, that ſilver and gold coin ſhall be ſtruck of ſuch denominations as the king ſhall think fit to appoint; in which the proportion of the metals above-determined ſhall be conſtantly obſerved through every denomination of the coin, until neceſſity ſhall make a new general coinage unavoidable.

5. To have the number of grains of the fine metal in every piece marked upon the exergue, or upon the legend of the coin, in place of ſome initial letters of titles, which not one perſon in a thouſand can decypher; and to make the coin of as compact a form as poſſible, diminiſhing the ſurface of it as much as is conſiſtent with beauty.

6. That it ſhall be lawful for all contracting parties to ſtipulate their payments either in gold or ſilver coin, or to leave the option of the ſpecies to one of the parties.

7. That where no particular ſtipulation is made, creditors ſhall have power to demand payment, half in one ſpecies, half in the other; and when the ſum cannot fall equally into gold and ſilver coins, the fractions to be paid in ſilver.

8. That in buying and ſelling, when no particular ſpecies has been ſtipulated, and when no act in writing has intervened, the option of the ſpecies ſhall be competent to the buyer.

9. That all ſums paid or received by the king's receivers, or by bankers, ſhall be delivered by weight, if demanded.

10. That all money which ſhall be found under the legal weight, from whatever cauſe it may proceed, may be rejected in every payment whatſoever; or if offered in payment of a debt above a certain ſum, may be taken according to its weight, at the then mint price, in the option of the creditor.

11. That no penalty ſhall be incurred by thoſe who melt down or export the nation's coin; but that waſhing, clipping, or diminiſhing the weight of any part of it ſhall be deemed felony, as much as any other theft, if the perſon ſo degrading the coin ſhall afterwards make it circulate for lawful money.

To prevent the inconveniencies proceeding from the variation in the proportion between the metals, it may be provided,

12. That upon every variation of proportion in the market-price of the metals, the price of both ſhall be changed, according to the following rule:

Let the price of the pound troy fine gold in the coin be called *G*.

Let the price of ditto in the ſilver be called *S*.

Let the new proportion between the market-price of the metals be called *P*.

Then ſtate this formula;

$\frac{G}{2P}+\frac{S}{2}=$ to a pound troy fine ſilver, in Sterling currency.

$\frac{S}{2}+P+\frac{G}{2}=$ to a pound troy fine gold, in Sterl. currency.

This will be a rule for the mint to keep the price of the metals conſtantly at par with the price of the market; and coinage may be impoſed, as has been deſcribed, by fixing the mint price of them at a certain rate below the value of the fine metals in the coin.

13. As long as the variation of the market-price of the metals ſhall not carry the price of the riſing metal ſo high as the advanced price of the coin above the bullion, no alteration need be made on the denomination of either ſpecies.

14. So soon as the variation of the market price of the metals shall give a value to the rising species, above the difference between the coin and the bullion; then the king shall alter the denominations of all the coin, silver and gold, adding to the coins of the rising metal exactly what is taken from those of the other. An example will make this plain:

Let us suppose that the coinage has been made according to the proportion of 14.5 to 1; that 20 shillings, or 4 crown-pieces, shall contain, in fine silver, 14.5 times as many grains as the guinea, or the gold pound, shall contain grains of fine gold. Let the new proportion of the metals be supposed to be 14 to 1. In that case, the 20 shillings, or the 4 crowns, will contain $\frac{1}{28}$ more value than the guinea. Now since there is no question of making a new general coinage upon every variation, in order to adjust the proportion of the metals in the weight of the coins, that proportion must be adjusted by changing their respective denominations according to this formula:

Let the 20 shillings, or 4 crowns, in coin, be called *S*. Let the guinea be called *G*. Let the difference between the old proportion and the new, which is $\frac{1}{29}$, be called *P*. Then say,

$$S - \frac{P}{2} = \text{a pound sterling, and } G + \frac{P}{2} = \text{a pound sterl.}$$

By this it appears that all the silver coin must be raised in its denomination $\frac{1}{58}$, and all the gold coin must be lowered in its denomination $\frac{1}{58}$; yet still S+G will be equal to two pounds Sterling, as before, whether they be considered according to the old or according to the new denominations.

But it may be observed, that the imposition of coinage rendering the value of the coin greater than the value of the bullion, that circumstance gives a certain latitude in fixing the new denominations of the coin, so as to avoid minute fractions. For, providing the deviation from the exact proportion shall fall within the advanced price of the coin, no advantage can be taken by melting down one species preferably to another; since, in either case, the loss incurred by melting the coin must be greater than the profit made upon selling the bullion. The mint price of the metals, however, may be fixed exactly, that is, within the value of a farthing upon a pound of fine silver or gold. This is easily reckoned at the mint; although upon every piece in common circulation the fractions of farthings would be inconvenient.

15. That notwithstanding of the temporary variations made upon the denomination of the gold and silver coins, all contracts formally entered into, and all stipulations in pounds shillings and pence, may continue to be acquitted according to the old denominations of the coins, paying one-half in gold, and one-half in silver: unless in the case where a particular species has been stipulated; in which case, the sums must be paid according to the new regulation made upon the denomination of that species, to the end that neither profit or loss may result to any of the parties.

16. That notwithstanding the alterations on the mint price of the metals, and in the denomination of the coins, no change shall be made upon the weight of the particular pieces of the latter, except in the case of a general re-coinage of one denomination at least: that is to say, the mint must not coin new guineas, crowns, &c. of a different weight from those already in currency, although by so doing the fractions might be avoided. This would occasion confusion, and the remedy would cease to be of any use upon a new change in the proportion of the metals. But it may be found convenient, for removing the small fractions in shillings and sixpences, to recoin such denominations all together, and to put them to their integer numbers, of twelve and of six pence, without changing in any respect their proportion of value to all other denominations of the coin: this will be no great expence, when the bulk of the silver coin is put into 5 shilling pieces.

By this method of changing the denominations of the coin, there never can result any alteration in the value of the pound Sterling; and although fractions of value may now and then be introduced, in order to prevent the abuses to which the coin would otherwise be exposed by the artifice of those who melt it down, yet still the inconvenience of such fractions may be avoided in paying, according to the old denominations, in both species, by equal parts. This will also prove demonstratively, that no change is thereby made in the true value of the national unit of money.

17. That it be ordered, that shillings and sixpences shall only be current for 20 years; and all other coins, both gold and silver, for 40 years, or more. For ascertaining which term, there may be marked, upon the exergue of the coin, the last year of their currency, in place of the date of their fabrication. This term elapsed, or the date effaced, that they shall have no more currency whatsoever; and, when offered in payment, may be received as bullion at the actual price of the mint, or refused, at the option of the creditor.

18. That no foreign coin shall have any *legal* currency, except as bullion at the mint price.

By these and the like regulations may be prevented, 1*mo*, The melting or exporting of the coin in general. 2*do*, The melting or exporting one species, in order to sell it as bullion at an advanced price. 3*tio*, The profit in acquitting obligations preferably in one species to another. 4*to*, The degradation of the standard, by the wearing of the coin, or by a change in the proportion between the metals. 5*to*, The circulation of the coin below the legal weight. 6*to*, The profit that other nations reap by paying their debts more cheaply to Great Britain than Great Britain can pay her's to them.

And the great advantage of it is, that it is an uniform plan, and may serve as a perpetual regulation, compatible with all kinds of denominations of coins, variations in the proportion of the metals, and with the imposition of a duty upon coinage, or with the preserving it free; and further, that it may in time be adopted by other nations, who will find the advantage of having their money of account preserved perpetually at the same value, with respect to the denominations of all foreign money of account established on the same principles.

A TABLE

A TABLE OF COINS,

Shewing the Quantity of Fine Metal contained in them.

The number of grains of fine metal in every coin is fought for in the regulations of the mint of the country where it is coined, and is expreffed in the grains in ufe in that mint. From that weight it is converted into thofe of other countries according to the following proportions:

3840 Troy gains, 4676.35 Paris grains, 5192.8 Holland aces or grains, and 4649.06 Colonia grains, are fuppofed to be equal weights; and the coins in the Table are converted according to thofe proportions.

	TABLE of COINS, reduced to Grains of fine Metal, according to the Troy, Paris, Colonia, and Holland weights.	GOLD COINS. Troy.	Paris.	Colonia.	Holland.	SILVER COINS. Troy.	Paris.	Colonia.	Holland.
English Coins.	1 A Guinea by ftatute — — — — —	118.651	144.46	143.65	160.45				
	2 A Crown by ftatute — — — —	— —	— —	— —	— —	429.68	523.2	520.2	581.
	3 A Shilling by ftatute — — — —	— —	— —	— —	— —	85.995	104.65	104.	116.2
	4 A Silver Pound Sterling by ftatute 1601 — —	— —	— —	— —	— —	1718.7	2093.	2080.8	2324.1
	5 A Gold Pound Sterling by ftatute 1728 — —	113.	137.61	136.8	152.8				
	6 A Silver Pound Sterling in currency = $\frac{20}{65}$ ℔. Troy —	— —	— —	— —	— —	1639.38	1996.4	1984.7	2216.
	7 A Silver Pound Sterl. at the proportion of gold to filver as 1 to $14\frac{1}{2}$	113.	137.61	136.8	152.8	1638.5	1995.3	1983.7	2215.7
	8 A Gold Pound Sterling at the fame proportion of 1 to $14\frac{1}{2}$	118.4	144.18	143.34	160.11	1718.7	2093.	2080.8	2324.1
	9 A Pound Sterling at the mean proportion in gold and in filver	115.769	140.98	140.16	156.55	1678.6	2044.2	2032.2	2269.9
	10 A Shilling current = $\frac{1}{65}$ of a pound Troy — —	— —	— —	— —	— —	81.961	99.8	99.	110.82
	11 A Guinea in Silver, or 21 Shillings ftandard weight —	— —	— —	— —	— —	1804.6	2197.6	2184.8	2440.3
	12 A Guinea at the proportion of 1 to $14\frac{1}{2}$, worth in filver	— —	— —	— —	— —	1720.4	2095.1	2082.8	2326.4
	13 A Pound Troy, or 12 ounces Englifh weight — —	5760.	7019.2	6973.5	7789.2				
French Coins.	1 A Louis d'or — — — —	113.27	137.94	137.13	153.17				
	2 A Crown of fix livres — — —	— —	— —	— —	— —	409.94	499.22	496.3	554.3
	3 A Crown of three ditto — — — —	— —	— —	— —	— —	204.97	249.61	248.15	277.1
	4 A livre — — — — —	— —	— —	— —	— —	68.34	83.23	82.74	92.42
	5 A Louis d'or, or 24 livres in filver — —	— —	— —	— —	— —	1639.7	1996.9	1985.2	2217.4
	6 A Marc of Paris weight, fine gold or filver — —	3783.87	4608.	4581.1	5116.9	3783.87	4608.	4581.1	5116.9
	7 A Marc of gold coin effective weight, in fine — —	3398.3	4138.5	4114.3	4593.4				
	8 A Mark of filver coin effective weight, in fine — —	— —	— —	— —	— —	3402.3	4143.4	4119.2	4600.9
German Coins.	1 A Carolin legal weight — — — —	115.45	140.6	139.78	156.12				
	2 A Ducat of the Empire ditto — — —	52.8	64.37	64.	71.48				
	3 A Florin of Convention — — —	— —	— —	— —	— —	179.73	218.87	217.6	243.
	4 A Dollar of Convention — — —	— —	— —	— —	— —	269.59	328.31	326.4	364.5
	5 A Dollar of Exchange, the Carolin = 9 flor. 42 kreutzers	17.85	21.74	21.615	24.14				
	6 A Florin current = $\frac{1}{11}$ of a Carolin — —	10.54	12.84	12.77	14.26				
	7 A Carolin in filver, at the proportion of 1 to $14\frac{1}{2}$ —	— —	— —	— —	— —	1674.	2038.6	2026.8	2263.8
Dutch Coins.	1 A Dutch Ducat — — — — — —	51.76	63.	62.67	70.				
	2 A Florin in filver — — — — — —	— —	— —	— —	— —	148.	180.3	179.2	200.21

UNIVER-

UNIVERSAL TABLE

Of the present State of the REAL and IMAGINARY MONIES of the World.

† This Mark is prefixed to the Imaginary Money, or Money of Account.

All Fractions in the Value English are Parts of a PENNY.

= This Mark signifies *is*, *make*, or *equal to*.

EUROPE, Northern Parts.

ENGLAND AND SCOTLAND.

London, Bristol, Liverpool, &c.
Edinburgh, Glasgow, Aberdeen, &c.

			£.	s.	d.
A Farthing		- -	0	0	$0\frac{1}{4}$
2 Farthings	=	a Halfpenny -	0	0	$0\frac{1}{2}$
2 Halfpence		a Penny -	0	0	1
4 Pence		a Groat -	0	0	4
6 Pence		a Half Shilling -	0	0	6
12 Pence		a Shilling -	0	1	0
5 Shillings		a Crown - -	0	5	0
20 Shillings		a †Pound Sterling -	1	0	0
21 Shillings		a Guinea -	1	1	0

IRELAND.

Dublin, Cork, Londonderry, &c.

			£.	s.	d.
A Farthing		- -	0	0	$0\frac{3}{13}$
2 Farthings	=	a Halfpenny -	0	0	$0\frac{6}{13}$
2 Halfpence		†a Penny - -	0	0	$0\frac{12}{13}$
$6\frac{1}{2}$ Pence		a Half Shilling -	0	0	6
12 Pence		†a Shilling Irish -	0	0	$11\frac{3}{40}$
13 Pence		a Shilling -	0	1	0
65 Pence		a Crown - -	0	5	0
20 Shillings		†a Pound - Irish -	0	18	$5\frac{1}{2}$
$22\frac{3}{4}$ Shillings		a Guinea -	1	1	0

FLANDERS AND BRABANT.

Ghent, Ostend, &c. Antwerp, Brussels, &c.

			£.	s.	d.
†A Pening		- -	0	0	$0\frac{9}{160}$
4 Peningens	=	an Urche -	0	0	$0\frac{9}{40}$
8 Peningens		†a Grote -	0	0	$0\frac{9}{20}$
2 Grotes		a Petard -	0	0	$0\frac{9}{10}$
6 Petards		†a Scalin -	0	0	$5\frac{2}{5}$
7 Petards		a Scalin -	0	0	$6\frac{3}{10}$
40 Grotes		†a Florin -	0	1	6
$17\frac{1}{2}$ Scalins		a Ducat -	0	9	3
240 Grotes		†a Pound Flem. -	0	9	0

HOLLAND AND ZEALAND.

Amsterdam, Rotterdam, Middleburg, Flushing, &c.

			£.	s.	d.
†Pening		- - -	0	0	$0\frac{21}{320}$
8 Peningens	=	†a Grote -	0	0	$0\frac{21}{40}$
2 Grotes		a Stiver -	0	0	$1\frac{1}{20}$
6 Stivers		a Scalin -	0	0	$6\frac{3}{10}$
20 Stivers		a Guilder -	0	1	9
50 Stivers		a Rix-dollar -	0	4	$4\frac{1}{4}$

EUROPE, Northern Parts.

HOLLAND, &c.

			£.	s.	d.
60 Stivers		a Dry Guilder	0	5	3
105 Stivers		a Ducat -	0	9	3
6 Guilders		†a Pound Flem.	0	10	6

GERMANY.

HAMBURG. *Altena, Lubec, Bremen, &c.*

			£.	s.	d.
†A Tryling	=	-	0	0	0 [illegible]
2 Trylings		†a Sexling -	0	0	0 [illegible]
2 Sexlings		a Fening -	0	0	0 [illegible]
12 Fenings		a Shilling Lub.	0	0	1
16 Shillings		†a Marc -	0	1	6
2 Marcs		a Slet dollar	0	3	0
3 Marcs		a Rix-dollar	0	4	6
$6\frac{1}{4}$ Marcs		a Ducat -	0	9	4
120 Shillings		†a Pound Flem.	0	11	3

HANOVER. *Lunenburgh, Zell, &c.*

			£.	s.	d.
†A Fening	=	- -	0	0	0 [illegible]
3 Fenings		a Dreyer -	0	0	0 [illegible]
8 Fenings		a Marien -	0	0	1
12 Fenings		a Grosh -	0	0	0 [illegible]
8 Groshen		a Half Gulden -	0	1	2
16 Groshen		a Gulden -	0	2	4
24 Groshen		†a Rix-dollar -	0	3	6
32 Groshen		a Double Gulden	0	4	8
4 Guldens		a Ducat -	0	9	2

SAXONY AND HOLSTEIN.

Dresden, Leipsig, &c. Wismar, Keil, &c.

			£.	s.	d.
†An Heller	=	- -	0	0	0 [illegible]
2 Hellers		a Fening -	0	0	0 [illegible]
6 Hellers		a Dreyer -	0	0	0 [illegible]
16 Hellers		a Marien -	0	0	1
12 Fenings		a Grosh - -	0	0	1
16 Groshen		a Gould -	0	2	4
24 Groshen		†a Rix-dollar -	0	3	6
32 Groshen		a Specie-dollar	0	4	8
4 Goulds		a Ducat -	0	9	4

BRANDENBURGH AND POMERANIA.

Berlin, Potsdam, &c. Stetin, &c.

			£.	s.	d.
†A Denier	=	- -	0	0	0 [illegible]
9 Deniers		a Polchen -	0	0	0 [illegible]
18 Deniers		a Grosh -	0	0	0 [illegible]
3 Polchens		an Abrass -	0	0	0 [illegible]
20 Groshen		†a Marc -	0	0	9

30 Grosh

EUROPE, Northern Parts. GERMANY.

BRANDENBURGH, &c.

		£.	s.	d.
30 Groshen	a Florin	0	1	2
90 Groshen	†a Rix-dollar	0	3	6
108 Groshen	an Albertus	0	4	2
8 Florins	a Ducat	0	9	4

COLOGN, *Mentz, Triers, Liege, Munich, Munster, Paderbourn, &c.*

		£.	s.	d.
A Dute		0	0	0 $\frac{7}{80}$
3 Dutes =	a Cruitzer	0	0	0 $\frac{21}{80}$
2 Cruitzers	an Albus	0	0	0 $\frac{21}{40}$
8 Dutes	a Stiver	0	0	0 $\frac{7}{10}$
3 Stivers	a Plapert	0	0	2 $\frac{1}{10}$
4 Plaperts	a Copstuck	0	0	8 $\frac{2}{5}$
40 Stivers	a Guilder	0	2	4
2 Guilders	a Hard Dollar	0	4	8
4 Guilders	a Ducat	0	9	4

BOHEMIA, SILESIA, AND HUNGARY.

Prague, Breslau, Presburg, &c.

		£.	s.	d.
A Fening		0	0	0 $\frac{7}{60}$
2 Fenings =	a Dreyer	0	0	0 $\frac{7}{30}$
3 Fenings	a Grosh	0	0	0 $\frac{7}{20}$
4 Fenings	a Cruitzer	0	0	0 $\frac{7}{15}$
2 Cruitzers	a White Grosh	0	0	0 $\frac{14}{15}$
60 Cruitzers	a Gould	0	2	4
90 Cruitzers	†a Rix-dollar	0	3	6
2 Goulds	a Hard Dollar	0	4	8
4 Goulds	a Ducat	0	9	4

AUSTRIA AND SWABIA.

Vienna, Tieste, &c. Ausburg, Blenheim, &c

		£.	s.	d.
A Fening		0	0	0 $\frac{7}{60}$
2 Fenings =	a Dreyer	0	0	0 $\frac{7}{30}$
4 Fenings	a Cruitzer	0	0	0 $\frac{7}{15}$
14 Fenings	a Grosh	0	0	1 $\frac{19}{30}$
4 Cruitzers	a Batzen	0	0	1 $\frac{13}{15}$
15 Batzen	a Gould	0	2	4
90 Cruitzers	†a Rix-dollar	0	3	6
30 Batzen	a Specie-dollar.	0	4	8
60 Batzen	a Ducat	0	9	4

FRANCONIA, *Francfort, Nuremburg, Dettingen, &c.*

		£.	s.	d.
A Fening		0	0	0 $\frac{7}{60}$
4 Fenings =	a Cruitzer	0	0	0 $\frac{7}{15}$
3 Cruitzers	a Keyser Grosh	0	0	1 $\frac{2}{5}$
4 Cruitzers	a Batzen	0	0	1 $\frac{13}{15}$
15 Cruitzers	an Ort Gould	0	0	7
60 Cruitzers	a Gould	0	2	4
90 Cruitzers	†a Rix-dollar	0	3	6
2 Goulds	a Hard Dollar	0	4	8
240 Cruitzers	a Ducat	0	9	4

POLAND AND PRUSSIA.

Cracow, Warsaw, &c. Dantzic, Koningsberg, &c.

		£.	s.	d.
A Shelon		0	0	0 $\frac{7}{45}$
3 Shelons =	a Grosh	0	0	0 $\frac{7}{15}$
5 Groshen	a Coustic	0	0	2 $\frac{1}{3}$
3 Coustics	a Tinfe	0	0	7

EUROPE, Northern Parts.

POLAND, &c.

		£.	s.	d.
18 Groshen	an Ort	0	0	8 $\frac{2}{5}$
30 Groshen	a Florin	0	1	2
90 Groshen	†a Rix-dollar	0	3	6
8 Florins	a Ducat	0	9	4
5 Rix-dollars	a Frederic d'Or	0	17	6

LIVONIA.

Riga, Revel, Narva, &c.

		£.	s.	d.
A Blacken		0	0	0 $\frac{7}{75}$
6 Blackens =	a Grosh	0	0	0 $\frac{7}{15}$
9 Blackens	a Vording	0	0	0 $\frac{7}{10}$
2 Groshen	a Whiten	0	0	0 $\frac{14}{15}$
6 Groshen	a Marc	0	0	2 $\frac{4}{5}$
30 Groshen	a Florin	0	1	2
90 Groshen	† a Rix-dollar	0	3	6
108 Groshen	an Albertus	0	4	2 $\frac{6}{15}$
64 Whitens	a Copper-plate Dollar	0	5	0

DENMARK, ZEALAND, AND NORWAY.

Copenhagen, Sound, &c. Bergen, Drontheim, &c.

		£.	s.	d.
A Skilling		0	0	0 $\frac{9}{16}$
6 Skillings =	a Duggen	0	0	3 $\frac{3}{8}$
16 Skillings	† a Marc	0	0	9
20 Skillings	a Rix-marc	0	0	11 $\frac{1}{4}$
24 Skillings	a Rix-ort	0	1	1 $\frac{1}{2}$
4 Marcs	a Crown	0	3	0
6 Marcs	a Rix-dollar	0	4	6
11 Marcs	a Ducat	0	8	3
14 Marcs	a Hatt Ducat	0	10	6

SWEDEN AND LAPLAND.

Stockholm, Upsal, &c. Thorn, &c.

		£.	s.	d.
† A Runstick		0	0	0 $\frac{7}{36}$
2 Runsticks =	a Stiver	0	0	0 $\frac{7}{18}$
8 Runsticks	a Copper Marc	0	0	1 $\frac{5}{9}$
3 Copper Marcs	a Silver Marc	0	0	4 $\frac{2}{3}$
4 Copper Marcs	a Copper Dollar	0	0	6 $\frac{2}{9}$
9 Copper Marcs	a Caroline	0	1	2
3 Copper Dollars	a Silver Dollar	0	1	6 $\frac{2}{3}$
3 Silver Dollars	a Rix-dollar	0	4	8
2 Rix-dollars	a Ducat	0	9	4

RUSSIA AND MUSCOVY.

Petersburg, Archangel, &c. Muscow, &c.

		£.	s.	d.
A Polusca		0	0	0 $\frac{27}{200}$
2 Poluscas =	a Denusca	0	0	0 $\frac{27}{100}$
2 Denuscas	†a Copec	0	0	0 $\frac{27}{50}$
3 Copecs	an Altin	0	0	1 $\frac{31}{50}$
10 Copecs	a Grievener	0	0	5 $\frac{2}{5}$
25 Copecs	a Polpotin	0	1	1 $\frac{1}{2}$
50 Copecs	a Poltin	0	2	3
100 Copecs	a Ruble	0	4	6
2 Rubles	a Xervonitz	0	9	0

BASIL. *Zurick, Zug, &c.*

		£.	s.	d.
A Rap		0	0	0 $\frac{1}{24}$
3 Rapen =	a Fening	0	0	0 $\frac{1}{8}$
4 Fenings	a Cruitzer	0	0	0 $\frac{1}{2}$
12 Fenings	†a Sol	0	0	1 $\frac{1}{2}$

15 Fe-

EUROPE, Southern Parts.

SWITZERLAND.

BASIL, &c.

			£.	s.	d.
15 Fenings	=	a Coarse Batzen	0	0	1 $\frac{7}{8}$
18 Fenings		a Good Batzen	0	0	2 $\frac{1}{4}$
20 Sols		†a Livre -	0	2	6
60 Cruitzers		a Gulden -	0	2	6
108 Cruitzers		a Rix-dollar	0	4	6

St GALL. *Appensal, &c.*

An Heller		- -	0	0	0 $\frac{1}{16}$
2 Hellers	=	a Fening -	0	0	0 $\frac{1}{8}$
4 Fenings		a Cruitzer	0	0	0 $\frac{1}{2}$
12 Fenings		†a Sol -	0	0	1 $\frac{1}{2}$
4 Cruitzers		a Coarse Batzen	0	0	2
5 Cruitzers		a Good Batzen	0	0	2 $\frac{1}{2}$
20 Sols		†a Livre -	0	2	6
60 Cruitzers		a Gould -	0	2	6
102 Cruitzers		a Rix-dollar	0	4	3

BERN. *Lucern, Neufchatel, &c.*

A Denier		- -	0	0	0 $\frac{1}{10}$
4 Deniers	=	a Cruitzer -	0	0	0 $\frac{2}{5}$
3 Cruitzers		†a Sol -	0	0	1 $\frac{1}{5}$
4 Cruitzers		a Plapert -	0	0	1 $\frac{3}{5}$
5 Cruitzers		a Gros -	0	0	2
6 Cruitzers		a Batzen -	0	0	2 $\frac{2}{5}$
20 Sols		†a Livre -	0	2	0
75 Cruitzers		a Gulden -	0	2	6
135 Cruitzers		a Crown -	0	4	6

GENEVA. *Pekay, Bonne, &c.*

A Denier		- - -	0	0	0 $\frac{1}{32}$
2 Deniers	=	a Denier current	0	0	0 $\frac{1}{16}$
12 Deniers		a Small Sol	0	0	0 $\frac{3}{8}$
12 Deniers current		a Sol current	0	0	0 $\frac{3}{4}$
12 Small Sols		†a Florin -	0	0	4 $\frac{1}{2}$
20 Sols current		†a Livre current	0	1	3
$10\frac{1}{2}$ Florins		a Patacon -	0	3	11 $\frac{1}{4}$
$15\frac{3}{4}$ Florins		a Croisade	0	5	10 $\frac{7}{8}$
24 Florins		a Ducat -	0	9	0

FRANCE and NAVARRE.

Lisle, Cambray, Valenciennes, &c.

A Denier		- - -	0	0	0 $\frac{1}{24}$
12 Deniers	=	a Sol -	0	0	0 $\frac{1}{2}$
15 Deniers		†a Patard -	0	0	0 $\frac{5}{8}$
15 Patards		†a Piette -	0	0	9 $\frac{3}{4}$
20 Sols		a Livere Tournois	0	0	10
20 Patards		†a Florin -	0	1	0 $\frac{1}{2}$
60 Sols		an Ecu of Ex.	0	2	6
$10\frac{1}{2}$ Livres		a Ducat -	0	9	3
24 Livres		a Lois d'Or	1	0	0

Dunkirk, St Omers, St Quintin, &c.

A Denier		- - -	0	0	0 $\frac{1}{24}$
12 Deniers	=	a Sol -	0	0	0 $\frac{1}{2}$
15 Deniers		†a Patard -	0	0	0 $\frac{5}{8}$
15 Sols		†a Piette -	0	0	7 $\frac{1}{2}$
20 Sols		†a Livre Tournois	0	0	10
3 Livres		an Ecu of Ex.	0	2	6
24 Livres		a Lois d'Or	1	0	0
24 Livres		a Guinea -	1	1	0
$30\frac{1}{8}$ Livres		a Moeda -	1	7	0

EUROPE, Southern Parts.

Paris, Lyons, Marseilles, &c. Bourdeaux, Bayonne, &c.

			£.	s.	d.
A Denier		- -	0	0	0 $\frac{1}{24}$
3 Deniers	=	a Liard -	0	0	0 $\frac{1}{8}$
2 Liards		a Dardene -	0	0	0 $\frac{1}{4}$
12 Deniers		a Sol -	0	0	0 $\frac{1}{2}$
20 Sols		†a Livre Tournois	0	0	10
60 Sols		an Ecu of Ex.	0	2	6
6 Livres		an Ecu -	0	5	0
10 Livres		†a Pistole -	0	8	4
24 Livres		a Louis d'Or	1	0	0

PORTUGAL. *Lisbon, Oporto, &c.*

† A Re		- - -	0	0	0 $\frac{27}{400}$
10 Rez	=	a Half Vintin -	0	0	0 $\frac{27}{40}$
20 Rez		a Vintin -	0	0	1 $\frac{7}{20}$
5 Vintins		a Testoon -	0	0	6 $\frac{3}{4}$
4 Testoons		a Crusade of Ex.	0	2	3
24 Vintins		a New Crusade -	0	2	8 $\frac{2}{5}$
10 Testoons		†a Milre - -	0	5	7 $\frac{1}{2}$
48 Testoons		a Moeda -	1	7	0
64 Testoons		a Joanese -	1	16	0

SPAIN and CATALONIA.

Madrid, Cadiz, Seville, &c. New Plate.

A Maravedie		- - -	0	0	0 $\frac{43}{272}$
2 Maravedies	=	a Quartil -	0	0	0 $\frac{43}{136}$
34 Maravedies		a Rial -	0	0	5 $\frac{3}{8}$
2 Rials		a Pistarine -	0	0	10 $\frac{3}{4}$
8 Rials		†a Piastre of Ex.	0	3	7
10 Rials		a Dollar - -	0	4	6
375 Maravedius		†a Ducat of Ex.	0	4	11 $\frac{1}{2}$
32 Rials		†a Pistole of Ex.	0	14	4
36 Rials		a Pistole -	0	16	9

Gibraltar, Malaga, Denia, &c. Velon.

† A Maravedie		- - -	0	0	0 $\frac{23}{272}$
2 Maravedies	=	a Ochavo	0	0	0 $\frac{23}{136}$
4 Maravedies		a Quartil	0	0	0 $\frac{23}{68}$
34 Maravedies		†a Rial Velon	0	0	2 $\frac{7}{8}$
15 Rials		†a Piastre of Ex.	0	3	7
512 Maravedies		a Piastre	0	3	7
60 Rials		†a Pistole of Ex.	0	14	4
2048 Maravedies		a Pistole of Ex.	0	16	9
78 Rials		a Pistole -	0	16	9

Barcelona, Saragossa, Valencia, &c. Old Plate.

A Maravedie		- -	0	0	0 $\frac{27}{128}$
16 Maravedies	=	a Soldo -	0	0	3 $\frac{3}{8}$
2 Soldos		a Rial Old Plate	0	0	6 $\frac{3}{4}$
20 Soldos		†a Libra -	0	5	7 $\frac{1}{2}$
24 Soldos		†a Ducat -	0	6	9
16 Soldos		†a Dollar -	0	4	6
22 Soldos		†a Ducat -	0	6	2 $\frac{1}{4}$
21 Soldos		†a Ducat -	0	5	10 $\frac{7}{8}$
60 Soldos		a Pistole -	0	16	9

ITALY.

GENOA. *Novi, &c.* CORSICA. *Bastia, &c.*

A Denari		- -	0	0	0 $\frac{43}{1200}$
12 Denari	=	a Soldi -	0	0	0 $\frac{43}{100}$
4 Soldi		a Chevalet	0	0	1 $\frac{18}{25}$
20 Soldi		†a Lire -	0	0	8 $\frac{3}{5}$
30 Soldi		a Testoon	0	1	0 $\frac{9}{10}$

EUROPE, Southern Parts. ITALY.

GENOA, &c.

			£.	s.	d.
5 Lires	=	a Croisade	0	3	7
115 Soldi		†a Pezzo of Ex.	0	4	2
6 Testoons		a Genouine	0	6	2
20 Lires		a Pistole	0	14	4

PIEDMONT, SAVOY, AND SARDINIA.

Turin, Chamberry, Cagliari, &c.

A Denari			0	0	$0\frac{1}{16}$
3 Denari	=	a Quatrini	0	0	$0\frac{3}{16}$
12 Denari		a Soldi	0	0	$0\frac{3}{4}$
12 Soldi		†a Florin	0	0	9
20 Soldi		†a Lire	0	1	3
6 Florins		a Scudi	0	4	6
7 Florins		a Ducatoon	0	5	3
13 Lires		a Pistole	0	16	3
16 Lires		a Louis d'Or	1	0	0

Milan, Modena, Parma, Pavia, &c.

A Denari			0	0	$0\frac{3}{82}$
3 Denari	=	a Quatrini	0	0	$0\frac{9}{82}$
12 Denari		a Soldi	0	0	$0\frac{18}{41}$
20 Soldi		†a Lire	0	0	$8\frac{32}{41}$
115 Soldi		a Scudi current	0	4	$2\frac{1}{2}$
117 Soldi		†a Scudi of Ex.	0	4	3
6 Lires		a Philip	0	4	$4\frac{1}{2}$
22 Lires		a Pistole	0	16	0
23 Lires		a Spanish Pistole	0	16	9

Leghorn. Florence, &c.

A Denari			0	0	$0\frac{5}{144}$
4 Denari	=	a Quatrini	0	0	$0\frac{5}{36}$
12 Denari		a Soldi	0	0	$0\frac{5}{12}$
5 Quatrini		a Craca	0	0	$0\frac{25}{36}$
8 Cracas		a Quilo	0	0	$5\frac{5}{9}$
20 Soldi		†a Lire	0	0	$8\frac{1}{3}$
6 Lires		a Piastre of Ex.	0	4	2
$7\frac{1}{2}$ Lires		a Ducat	0	5	$2\frac{1}{2}$
22 Lires		a Pistole	0	15	6

ROME, *Civita, Vecchia, Ancona.*

A Quatrini			0	0	$0\frac{3}{20}$
5 Quatrini	=	a Bayoc	0	0	$0\frac{3}{4}$
8 Bayocs		a Julio	0	0	6
10 Bayocs		a Stampt Julio	0	0	$7\frac{1}{2}$
24 Bayocs		a Testoon	0	1	6
10 Julios		a Crown current	0	5	0
12 Julios		†a Crown stampt	0	6	0
18 Julios		a Chequin	0	9	0
31 Julios		a Pistole	0	15	6

NAPLES. *Gaieta, Capua, &c.*

A quatrini			0	0	$0\frac{2}{15}$
3 Quatrini	=	a Grain	0	0	$0\frac{2}{5}$
10 Grains		a Carlin	0	0	4
40 Quatrini		a Paulo	0	0	$5\frac{1}{3}$
20 Grains		a Tarin	0	0	8
40 Grains		a Testoon	0	1	4
100 Grains		a Ducat of Ex.	0	3	4
23 Tarins		a Pistole	0	15	4
25 Tarins		a Spanish Pistole	1	16	9

EUROPE, Southern Parts. ITALY.

SICILY AND MALTA. *Palermo, Messina, &c.*

			£.	s.	d.
A Pichila			0	0	$0\frac{1}{39}$
6 Pichili	=	a Grain	0	0	$0\frac{2}{13}$
8 Pichili		a Ponti	0	0	$0\frac{8}{39}$
10 Grains		a Carlin	0	0	$1\frac{7}{13}$
20 Grains		a Tarin	0	0	$3\frac{1}{13}$
6 Tarins		†a Florin of Ex.	0	1	$6\frac{6}{13}$
13 Tarins		a Ducat of Ex.	0	3	4
60 Carlins		†an Ounce	0	7	$8\frac{4}{13}$
2 Ounces		a Pistole	0	15	4

Bologna, Ravenna, &c.

A Quatrini			0	0	$0\frac{1}{10}$
6 Quatrini	=	a Bayoc	0	0	$0\frac{3}{5}$
10 Bayocs		†a Julio	0	0	6
20 Bayocs		a Lire	0	1	0
3 Julios		a Testoon	0	1	6
80 Bayocs		a Scudi of Ex.	0	4	3
105 Bayocs		a Ducatoon	0	5	3
100 Bayocs		a Crown	0	5	0
31 Julios		a Pistole.	0	15	6

VENICE. *Bergham, &c.*

A Picoli			0	0	$0\frac{1}{36}$
12 Picoli	=	a Soldi	0	0	$0\frac{1}{3}$
$6\frac{1}{2}$ Soldi		†a Gros	0	0	$2\frac{1}{6}$
18 Soldi		a Jule	0	0	6
20 Soldi		†a Lire	0	0	$6\frac{2}{3}$
3 Jules		a Testoon	0	1	6
124 Soldi		a Ducat current	0	3	$5\frac{1}{3}$
24 Gros		†a Ducat of Ex.	0	4	4
17 Lires		a Chequin	0	9	2

TURKEY. *Morea, Candia, Cyprus, &c.*

A Mangar			0	0	$0\frac{3}{20}$
4 Mangars	=	†an Asper	0	0	$0\frac{3}{5}$
3 Aspers		a Parac	0	0	$1\frac{4}{5}$
5 Aspers		a Bestic	0	0	3
10 Aspers		an Ostic	0	0	6
20 Aspers		a Solota	0	1	0
80 Aspers		†a Piastre	0	4	0
100 Aspers		a Caragrouch	0	5	0
10 Solotas		a Xeriff	0	10	0

ASIA.

ARABIA. *Medina, Mecca, Mocha, &c.*

A Carret			0	0	$0\frac{1}{8}$
$5\frac{1}{4}$ Carrets	=	a Caveer	0	0	$0\frac{1}{2}\frac{25}{160}$
7 Carrets		a Comashee	0	0	$0\frac{9}{10}$
80 Carrets		a Larin	0	0	$10\frac{1}{8}$
18 Comashees		an Abyss	0	1	$4\frac{1}{5}$
60 Comashees		†a Piastre	0	4	6
80 Caveers		a Dollar	0	4	6
100 Comashees		a Sequin	0	7	6
80 Larins		†a Tomond	3	7	6

PERSIA. *Ispahan, Ormus, Gombroon, &c*

A Coz			0	0	$0\frac{2}{5}$
4 Coz	=	a Bisti	0	0	$1\frac{3}{5}$
10 Coz		a Shahee	0	0	4
20 Coz		a Mamooda	0	0	8
25 Coz		a Larin	0	0	10
4 Shahees		an Abashee	0	1	4

5 Abashees

			£.	s.	d.
5 Abashees	=	an Or	0	8	6
12 Abashees		a Bovello	0	16	0
50 Abashees		†a Tomond	3	6	8

ASIA.

MOGUL.

GUZZURAT. *Surat, Cambay, &c.*

			£.	s.	d.
A Pecka			0	0	$0\frac{15}{64}$
2 Peckas	=	a Pice	0	0	$0\frac{15}{32}$
4 Pices		a Fanam	0	0	$1\frac{7}{8}$
5 Pices		a Viz	0	0	$2\frac{11}{32}$
10 Pices		an Ana	0	0	$7\frac{1}{2}$
4 Anas		a Rupee	0	2	6
2 Rupees		an English Crown	0	5	0
14 Anas		a Pagoda	0	8	9
4 Pagodas		a Gold Rupee	1	15	0

MALABAR.

Bombay, Dabul, &c.

			£.	s.	d.
†A Budgrook			0	0	$0\frac{27}{800}$
2 Budgrooks	=	†a Re	0	0	$0\frac{27}{400}$
5 Rez		a Pice	0	0	$0\frac{27}{80}$
16 Pices		a Laree	0	0	$5\frac{2}{5}$
20 Pices		a Quarter	0	0	$6\frac{3}{4}$
240 Rez		a Xeraphim	0	1	$4\frac{1}{5}$
4 Quarters		a Rupee	0	2	3
14 Quarters		a Pagoda	0	8	0
60 Quarters		a Gold Rupee	1	15	0

Goa, Visapour, &c.

			£.	s.	d.
†A Re			0	0	$0\frac{27}{400}$
2 Rez	=	a Bazaraco	0	0	$0\frac{27}{200}$
2 Bazaracos		a Pecka	0	0	$0\frac{27}{100}$
20 Rez		a Vintin	0	0	$1\frac{7}{20}$
4 Vintins		a Laree	0	0	$5\frac{2}{5}$
3 Larees		a Xeraphim	0	1	$4\frac{1}{5}$
42 Vintins		a Tangu	0	4	6
4 Tangus		a Paru	0	18	0
8 Tangus		a Gold Rupee	1	15	0

COROMANDEL. *Madrass, Pondicherry, &c.*

			£.	s.	d.
A cash			0	0	$0\frac{5}{32}$
5 Cash	=	a Viz	0	0	$0\frac{3}{16}$
2 Viz		a Pice	0	0	$0\frac{3}{8}$
6 Pices		a Pical	0	0	$2\frac{1}{4}$
8 Pices		a Fanam	0	0	3
10 Fanams		a Rupee	0	2	6
2 Rupees		an English Crown	0	5	0
36 Fanams		a Pagoda	0	8	9
4 Pagodas		a Gold Rupee	1	15	0

BENGAL. *Callicut, Calcutta, &c.*

			£.	s.	d.
A Pice			0	0	$0\frac{5}{32}$
4 Pices	=	a Fanam	0	0	$0\frac{5}{8}$
6 Pices		a Viz	0	0	$0\frac{15}{16}$
12 Pices		an Ana	0	0	$1\frac{7}{8}$
10 Anas		a Fiano	0	1	$6\frac{3}{4}$
16 Anas		a Rupee	0	2	6
2 Rupees		a French Ecu	0	5	0
2 Rupees		an English Crown	0	5	0
56 Anas		a Pagoda	0	8	9

SIAM. *Pegu, Malacca, Cambodia, Sumatra, Java, Borneo, &c.*

			£.	s.	d.
A Cori			0	0	$0\frac{3}{40000}$
800 Cori	=	a Fettee	0	0	$0\frac{3}{50}$
125 Fettees		a Sataleer	0	0	$7\frac{1}{2}$
250 Fettees		a Sooco	0	1	3
500 Fettees		a Tutal	0	2	6
900 Fettees		a Dollar	0	4	6
2 Ticals		a Rial	0	5	0
4 Soocos		an Ecu	0	5	0
8 Sateleers		a Crown	0	5	0

ASIA.

CHINA. *Pekin, Canton, &c.*

			£.	s.	d.
A Caxa			0	0	$0\frac{2}{25}$
10 Caxa	=	a Candereen	0	0	$0\frac{4}{5}$
10 Candereens		a Mace	0	0	8
35 Candereens		a Rupee	0	2	6
2 Rupees		a Dollar	0	4	6
70 Candereens		a Rix-dollar	0	4	$4\frac{1}{2}$
7 Maces		an Ecu	0	5	0
2 Rupees		a Crown	0	5	0
10 Maces		†a Tale	0	6	8

JAPAN. *Jedda, Meaco, &c.*

			£.	s.	d.
A Piti			0	0	$0\frac{1}{5}$
20 Pitis	=	a Mace	0	0	4
15 Maces		an Ounce Silver	0	4	$10\frac{1}{3}$
20 Maces		a Tale	0	6	8
30 Maces		an Ingot	0	9	$8\frac{2}{3}$
13 Ounces Silver		an Ounce Gold	3	3	0
2 Ounces Gold		a Japanese	6	6	0
2 Japaneses		a Double	12	12	0
21 Ounces Gold		†a Cattee	66	3	0

AFRICA.

EGYPT. *Old and New Cairo, Alexandria, Sayde, &c.*

			£.	s.	d.
An Asper			0	0	$0\frac{5}{9}$
3 Aspers	=	a Medin	0	0	$1\frac{2}{3}$
24 Medins		an Italian Ducat	0	3	4
80 Aspers		†a Piastre	0	4	0
30 Medins		a Dollar	0	4	6
96 Aspers		an Ecu	0	5	0
32 Medins		a Crown	0	5	0
200 Aspers		a Sultanin	0	10	0
70 Medins		a Pargo Dollar	0	10	6

BARBARY. *Algiers, Tunis, Tripoli, Una, &c.*

			£.	s.	d.
An Asper			0	0	$0\frac{5}{9}$
3 Aspers	=	a Medin	0	0	$1\frac{2}{3}$
10 Aspers		a Rial old Plate	0	0	$6\frac{1}{3}$
2 Rials		a Double	0	1	$1\frac{1}{2}$
4 Doubles		a Dollar	0	4	6
24 Medins		a Silver Chequin	0	3	4
30 Medins		a Dollar	0	4	6
180 Aspers		a Zequin	0	8	10
15 Doubles		a Pistole	0	16	9

MOROCCO. *Santa Cruz, Mequinez, Fez, Tangiers, Sallee, &c.*

			£.	s.	d.
A Fluce			0	0	$0\frac{1}{12}$
24 Fluces	=	a Blanquil	0	0	2

AFRICA.

MOROCCO, &c.

			£.	s.	d.
4 Blanquils	=	an Ounce	0	0	8
7 Blanquils		an Octavo	0	1	2
14 Blanquils		a Quarto	0	2	4
2 Quartos		a Medio	0	4	8
28 Blanquils		a Dollar	0	4	6
54 Blanquils		a Xequin	0	9	0
100 Blanquils		a Pistole	0	16	9

AMERICA. West-Indies.

ENGLISH. *Jamaica, Barbadoes, &c.*

			£.	s.	d.
†Halfpenny			0	0	$0\frac{57}{160}$
2 Halfpence	=	†a Penny	0	0	$0\frac{57}{80}$
$7\frac{1}{2}$ Pence		a Bit	0	0	$5\frac{3}{8}$
12 Pence		†a Shilling	0	0	$8\frac{11}{20}$
75 Pence		a Dollar	0	4	6
7 Shillings		a Crown	0	5	0
20 Shillings		†a Pound	0	14	3
24 Shillings		a Pistole	0	16	9
30 Shillings		a Guinea	1	1	0

FRENCH. *St Domingo, Martinico, &c.*

			£.	s.	d.
†A Half Sol			0	0	$0\frac{117}{640}$
2 Half Sols	=	†a Sol	0	0	$0\frac{117}{320}$
$7\frac{1}{2}$ Sols		a Half Scalin	0	0	$2\frac{11}{16}$
15 Sols		a Scalin	0	0	$5\frac{3}{8}$
20 Sols		†a Livre	0	0	$7\frac{5}{16}$
7 Livres		a Dollar	0	4	6
8 Livres		an Ecu	0	4	$10\frac{1}{2}$
26 Livres		a Pistole	0	16	9
32 Livres		a Louis d'Or	1	0	0

AMERICA. Continent.

ENGLISH. *Nova Scotia, Virginia, New England, &c.*

			£.	s.	d.
† A Penny			0	0	1
12 Pence	=	†a Shilling	0	1	0
20 Shillings		†a Pound	1	0	0
2 Pounds					
3 Pounds					
4 Pounds		The value of the Currency alters according to the Plenty or Scarcity of Gold and Silver Coins that are imported.			
5 Pounds					
6 Pounds					
7 Pounds					
8 Pounds					
9 Pounds					
10 Pounds					

Canada, Florida, Cayena, &c.

† A Denier		
12 Deniers	=	†a Sol
20 Sols		†a Livre.
2 Livres		
3 Livres		
4 Livres		The Value of the Currency alters according to the Plenty or Scarcity of Gold and Silver Coins that are imported.
5 Livres		
6 Livres		
7 Livres		
8 Livres		
9 Livres		
10 Livres		

Note. For all the *Spanish*, *Portuguese*, *Dutch*, and *Danish* Dominions, either on the Continent or in the West Indies, see the Moneys of the respective nations.

Monk.

MONK, a person who wholly dedicates himself to the service of religion, in some monastery, under the direction of particular statutes and rules.

The most probable account of the original of the monks is, that in the Decian persecution, in the middle of the third century, many persons in Egypt, to avoid the fury of the storm, fled to the neighbouring desarts and mountains, where they not only found a safe retreat, but also more time and liberty to exercise themselves in acts of piety and divine contemplations; which sort of life became so agreeable, that, when the persecution was over, they refused to return to their habitations again, choosing rather to continue in those cottages and cells which they had made for themselves in the wilderness. From that time to the reign of Constantine, monachism was confined to the hermits or anachorets, who lived in private cells in the wilderness: but when Pachomius had erected MONASTERIES, other countries presently followed the example.

The manner of admission to the monastic life was usually by some change of habit; not to signify any religious mystery, but only to express their gravity and contempt of the world. Long hair was always thought an indecency in men, and favouring of secular vanity; and therefore they polled every monk at his admission, to distinguish him from seculars; but they never shaved them, lest they should look like the priests of Isis. St Jerom, speaking of the habits of the monks, intimates that it differed from that of others only in this, that it was cheaper, coarser, and meaner raiment. We read of no solemn vow, or profession, required at their admission; but they underwent a triennial probation, during which time they were inured to the exercises of the monastic life. If, after that time was was expired, they chose to continue the same exercises, they were then admitted, without any farther ceremony, into the community. As the monasteries had no standing revenues, all the monks were obliged to maintain themselves by their daily labour: they had no idle mendicants among them; but looked upon a monk who did not work, as a covetous defrauder. Every ten monks were subject to one, who was called the *decanus*, or *dean*, from his presiding over ten; and every hundred had another officer called *centenarius*, from his presiding over an hundred; and above these were the fathers of the monasteries, also called *abbots*. The business of the deans was to exact every man's daily task, and carry it to the steward, who gave a monthly account of it to the abbot. See ABBOT.

For a particular account of the present monastic orders, see AUGUSTINS, BENEDICTINES, CARMELITES, DOMINICANS, FRANCISCANS, &c.

MONK (George), a personage memorable for having been the principal agent in restoring Charles II. to his crown, was descended from a very ancient family, and born in Devonshire in 1608. Being an unprovided younger son, he dedicated himself to arms from his youth, and obtained a pair of colours in the expedition to the Isle of Rhée: he served afterwards in the Low Countries with reputation in both king Charles's northern expeditions; and did such service in quelling the Irish rebellion, that he was appointed governor of Dublin,

Dublin, but was ſuperſeded by parliamentary authority. Being made major-general of the Iriſh brigade employed in the ſiege of Nantwich in Cheſhire, he was taken priſoner by Sir Thomas Fairfax, and remained confined in the tower of London until the year 1646; when, as the means of liberty, he took the Covenant, and accepted a command in the Iriſh ſervice under the parliament. He obtained the command in chief of all the parliamentary forces in the north of Ireland, where he did ſignal ſervices, until he was called to account for a treaty made with the Iriſh rebels; a circumſtance which was only obliterated by his future good fortune. He ſerved againſt Charles II. under Oliver Cromwell with ſuch ſucceſs, that Oliver left him there as commander in chief; and he was one of the commiſſioners for uniting that kingdom with the new-erected commonwealth. He ſerved at ſea alſo againſt the Dutch; and was treated ſo kindly on his return, that Oliver is ſaid to have grown jealous of him. He was, however, again ſent to Scotland as commander in chief, and continued there five years: when he diſſembled ſo well, and improved circumſtances ſo dextrouſly, that he aided the deſires of a wearied people, and reſtored the king without any diſturbance; for which he was immediately rewarded both with honours and profits. See Britain, n° 194, &c.—He was created duke of Albemarle, with a grant of 7000l. *per annum* eſtate, beſide other emoluments; and enjoyed the confidence of his maſter without forfeiting that of the people. After his death, in 1670, there was publiſhed a treatiſe compoſed by him while he remained priſoner in the tower, intitled, *Obſervations on military and political affairs*, a ſmall folio.

Monkey, in zoology. See Ape, and Simia.

Monks-*Hood*, or *Wolf's-bane*. See Aconitum.

Since the time of Theophraſtus, moſt of the ſpecies of monks-hood have been reckoned a deadly poiſon both to men and brutes. Dioſcorides, however, recommends the external application of common monks-hood for pains of the eyes. The flowers of a great many ſpecies communicate their noxious quality by being ſmelled to; and thoſe of the ſpecies called *napellus* being placed on the head, occaſion a violent megrim. Of the bad qualities of theſe plants we ſometimes avail ourſelves to get rid of vermin. A decoction of the roots deſtroys bugs; the ſame part being powdered and adminiſtered in bread or ſome other palatable vehicle, to rats and mice, corrodes and inflames their inteſtines, and ſoon proves mortal. The juice of the plant is uſed to poiſon fleſh with, for the deſtruction of wolves, foxes, and other ravenous beaſts. The beſt antidote to the poiſon of the different monks-hoods is ſaid to be the root of a ſpecies of the ſame genus, hence termed *healthful* or *wholeſome monks-hood*. It is the *aconitum anthora* of Linnæus. The ſame plant is regarded as efficacious againſt bites of ſerpents and other venomous creatures. The roots have a bitter acrid taſte; the leaves are only bitter: the former are chiefly uſed in medicine; and, beſides the excellent quality juſt mentioned, are ſtomachic, and promote perſpiration. The peaſants, who gather the plants on the Alps and Pyrenees, are ſaid to uſe it with ſucceſs againſt the biting of mad dogs, and to cure the colic. It is remarkable, that the monks-hoods with blue flowers are much more virulent than the yellow or white-flowered kinds. Miller aſſerts that the huntſmen of the wolves and other wild beaſts on the Alps, dip their arrows into the juice of thoſe plants, which renders the wounds made by them deadly.

MONMOUTH (James, duke of), ſon to Charles II. by Mrs Lucy Walters, was born at Rotterdam in 1649. Upon the Reſtoration, he was called over to England, where the king received him with all imaginable joy, created him earl of Orkney (which was changed into that of Monmouth), and he took his ſeat in the houſe of peers in the enſuing ſeſſion of parliament. He married Anne, the heireſs of Francis earl of Buccleugh; and hence it came to paſs that he had alſo the title of *Buccleugh*, and took the ſirname of *Scot*, according to the cuſtom of Scotland. In 1668 his father made him captain of his life-guard of horſe; and in 1672 he attended the French king in the Netherlands, and gave proofs of bravery and conduct. In 1673 the king of France made him lieutenant-general of his army, with which he came before Maeſtricht, and behaved himſelf with incredible gallantry, being the firſt who entered it himſelf. He returned to England, was received with all poſſible reſpect, and was elected chancellor of the univerſity of Cambridge. After this he went to aſſiſt the prince of Orange to raiſe the ſiege of Mons, and did not a little contribute towards it. He returned to England; and was ſent, in quality of his father's general, to quell an inſurrection in Scotland, which he effected: but ſoon after he fell into diſgrace; for, being a Proteſtant, he was deluded into ambitious ſchemes, upon the hopes of the excluſion of the duke of York: he conſpired againſt his father and the duke; and when the latter came to the throne by the title of *James II.* he openly appeared in arms, encouraged by the Proteſtant army; but coming to a deciſive battle before he had ſufficient forces to oppoſe the royal army, he was defeated, taken ſoon after concealed in a ditch, tried for high-treaſon, condemned, and beheaded in 1685, aged 36. See Britain, n° 242. 249—265.

Monmouth, the capital of the county of Monmouthſhire in England. It has its name from its ſituation at the conflux of the Monow, or Mynwy, and Wye. Here was a caſtle in William the Conqueror's time, which Henry III. took from John baron of Monmouth. It afterwards came to the houſe of Lancaſter, who beſtowed many privileges upon the town. Here Henry V. ſirnamed *of Monmouth*, was born. The famous hiſtorian Geoffrey was alſo born at this place. Formerly it gave the title of *earl* to the family of Carey, and of *duke* to king Charles the ſecond's eldeſt natural ſon; but now of *earl* to the Mordaunts, who are alſo earls of Peterborough. It is a populous and well-built place, and carries on a conſiderable trade with Briſtol by means of the Wye. W. Long. 2. 30. N. Lat. 51. 47.

Monmouthshire, a county of England; anciently reckoned a part of Wales, but in Charles the ſecond's time taken into the Oxford circuit, and made an Engliſh county. It has Brecknockſhire and Herefordſhire on the north, from the latter of which it is ſeparated by the Monow; Glouceſterſhire on the eaſt, from which it is ſeparated by the Wye; Glamorganſhire on the weſt, and the river Rumney running between them; and on the ſouth it is bounded by the

Severn fea, into which thefe rivers, and alfo the Ufk, difcharge themfelves. It is about 29 miles in length, and 20 in breadth. The country is in fome parts woody, and in others hilly: yet the air is nowhere bad, nor the foil barren; for the hills feed large flocks of black cattle, fheep and goats, and the valleys produce plenty of corn. It is alfo well watered; and fo plentifully fupplied with coal, that the pooreft cottager can afford to keep a good fire all the winter. The county fends three members to parliament. The principal manufacture is flannel.

MONOCHORD, a mufical inftrument with only one ftring, ufed to try the variety and proportion of founds. It is formed of a rule, divided and fubdivided into feveral parts, on which there is a moveable ftring ftretched upon two bridges at each extreme. In the middle between thefe is a moveable bridge, by means of which, in applying to it the different divifions of the line, the founds are found to bear the fame proportion to each other as the divifion of the line cut by the bridge. There are alfo monochords with 48 fixed bridges. This inftrument is alfo called the *harmonical canon*, or the *canonical rule*, becaufe it ferves to meafure the degrees of gravity or acutnefs.—*Monochord* is alfo ufed for any mufical inftrument that confifts of only one ftring or chord; in this fenfe the trumpet marine may properly be called a *monochord.*

MONODON, in ichthyology, a genus of fifhes belonging to the order of cete. It has a long wreathed tooth in the upper jaw, which perforates the upper lip, and has the appearance of a horn; from this circumftance it has got the name of the *unicorn-fifh.* It is the *narwhal* of Pontopiddan, and is of the whale kind. Sometimes it grows to 25 feet in length; but the ufual fize is from 16 to 20.

MONODY, in ancient poetry, a mournful kind of fong, fung by a perfon all alone, to give vent to his grief. The word is derived from μονος "alone," and ᾀδω "I fing."

MONOECIA, from μονος "alone," and οικια "a houfe;" the name of the 21ft clafs in Linnæus's fexual method. See Botany, nº 1296.

MONOGRAM, a character or cypher, compofed of one, two, or more letters, interwoven; being a kind of abbreviation of a name, anciently ufed as a feal, badge, arms, &c.

MONOGYNIA, from μονος "alone," and γυνη "a woman;" the name of the firft order or fubdivifion in the firft 13 claffes of Linnæus's fexual method; confifting of plants which, befides their ageement in their claffic character, generally derived from the number of their ftamina, have only one ftile, or female organ.

MONOMOTAPA, a country of Africa, has the maritime kingdom of Sofala on the eaft, the river Del Spiritu Santo on the fouth, the mountains of Caffraria on the weft, and the river Cauma on the north, which parts it from Monoemugi. The air of this country is very temperate; the land fertile in paftures and all the neceffaries of life, being watered by feveral rivers. The inhabitants are rich in black cattle, which they value more than gold. They have a vaft number of elephants, as appears from the great quantity of ivory that is exported from hence. There are many gold-mines, and the rivers that run through their veins carry a great deal of gold-duft along with

them. The inhabitants are lovers of war, which is the employment followed by all thofe who do not apply themfelves to commerce. This country is divided into feven provinces or petty kingdoms, vaffals to the king; viz. Monomotapa Proper, Quiteve, Manica, Inhambàna, Inhemior, Sabia, and Sofala.

MONOPETALOUS, in botany, a term applied to flowers that have only one petal or flower-leaf.

MONOPOLY, one or more perfons making themfelves the fole mafters of the whole of a commodity, manufacture, and the like, in order to make private advantage of it, by felling it again at a very advanced price. Or it is a licence or privilege allowed by the king for the fole buying and felling, making, working, or ufing any thing whatfoever.—Monopolies had been carried to an enormous height during the reign of queen Elizabeth; and were heavily complained of by Sir Edward Coke, in the beginning of the reign of king James the firft: but were in great meafure remedied by ftatute 21 Jac. I. c. 3. which declares fuch monopolies to be contrary to law, and void; (except as to patents, not exceeding the grant of fourteen years, to the authors of new inventions; and except alfo patents concerning printing, faltpetre, gunpowder, great ordinance, and fhot); and monopolifts are punifhed with the forfeiture of treble damages and double cofts, to thofe whom they attempt to difturb; and if they procure any action, brought againft them for thefe damages, to be ftayed by any extrajudicial order, other than of the court wherein it is brought, they incur the penalties of *præmunire.* Combinations alfo among victuallers or artificers, to raife the price of provifions, or any commodities, or the rate of labour, are in many cafes feverely punifhed by particular ftatute; and, in general, by ftatute 2 & 3 Edward VI. c. 15. with the forfeiture of 10 *l.* or twenty days imprifonment, with an allowance of only bread and water, for the firft offence; 20 *l.* or the pillory, for the fecond; and 40 *l.* for the third, or elfe the pillory, lofs of one ear, and perpetual infamy. In the fame manner, by a conftitution of the emperor Zeno, all monopolies and combinations to keep up the price of merchandife, provifions, or workmanfhip, were prohibited, upon pain of forfeiture of goods and perpetual banifhment.

MONOSYLLABLE, in grammar, a word that confifts only of one fyllable, and is compofed either of one or more letters pronounced at the fame time. The too frequent ufe of monofyllables has a very bad effect in Englifh poetry, as Mr Pope both intimates and exemplifies in the fame verfe, viz.

> "And ten flow words oft creep in one dull line."

MONOTONY, an uniformity of found, or a fault in pronunciation, when a long feries of words are delivered in one unvaried tone. See Reading.

MONOTROPA, Bird's-nest; a genus of the monogynia order, belonging to the decandria clafs of plants. There are two fpecies; of which the only remarkable one is the hippopithys, a native of Britain and fome of the more northerly kingdoms of Europe It is about five inches high, having no other leaves than oval fcales, and terminated with a nodding fpike of flowers, which in the feeding-ftate becomes erect: the whole plant is of a pale-yellow colour, fmelling like the primrofe, or like beans in bloffom. The country-people in Sweden give the dried plant to

Monro.

cattle that have a cough.

MONRO (Dr Alexander, fenior), a moft eminent phyfician and anatomift, was defcended by his father from the family of Monro of Milton, which had large poffeffions in the county of Rofs; and by his mother, from that of Forbes of Culloden.

His father John, youngeft fon of Sir Alexander Monro of Bearcrofts, was bred to phyfic and furgery, and ferved for fome years as a furgeon in the army under king William in Flanders: but, for feveral fucceffive years, obtaining leave of abfence from the army in the winter, he during that feafon refided with his wife in London, where his fon Alexander was born in the 1697. About three years thereafter, he quitted the army, and went to fettle as a furgeon at Edinburgh; where his knowledge in his profeffion, and engaging manners, foon introduced him into an extenfive practice.

The fon fhewed an early inclination to the ftudy of phyfic; and the father, after giving him the beft education that Edinburgh then afforded, fent him fucceffively to London, Paris, and Leyden, to improve himfelf further in his profeffion. At London, he attended the lectures of Meffrs Hawkfbee and Whifton on experimental philofophy, and the anatomical demonftrations of Mr Chefelden. At Paris, he attended the hofpitals, and the lectures which were read on the different branches of phyfic and furgery at that time. Towards the end of autumn 1718, he went to Leyden, and ftudied under the great Boerhaave; by whom he was particularly efteemed.

On his return to Edinburgh in autumn 1719, Meffrs Drummond and Macgill, who were then conjunct nominal profeffors and demonftrators of anatomy to the furgeons company, having refigned in his favour, his father prevailed on him to read fome public lectures on anatomy, and to illuftrate them by fhewing the curious anatomical preparations which he had made and fent home when abroad. He at the fame time perfuaded Dr Alfton, then a young man, to give fome public lectures on botany. Accordingly, in the beginning of the winter 1720, thefe two young profeffors began to give regular courfes of lectures, the one on the materia medica and botany, the other on anatomy and furgery; which were the firft regular courfes of lectures on any of the branches of medicine that had ever been read at Edinburgh, and may be looked upon as the opening of that medical fchool which has fince acquired fuch great reputation all over Europe.

In fummer 1721 and 1722, Dr Monro, by the perfuafion of his father, read fome lectures on chirurgical fubjects; particularly on wounds and tumours, which he never would publifh, having wrote them in a hurry and before he had much experience; but inferted from time to time the improvements he thought might be made in furgery, in the volumes of Medical Effays and Obfervations to be hereafter mentioned.

About the year 1720, his father communicated to the phyficians and furgeons at Edinburgh, a plan, which he had long formed in his own mind, of having the different branches of phyfic and furgery regularly taught at Edinburgh; which was highly approved of by them, and by their intereft regular profefforfhips of anatomy and medicine were inftituted in the univerfity. His fon, Dr Monro, was firft made univerfity-profeffor of anatomy; and two or three years afterwards, Drs Sinclair, Rutherford, Innes, and Plummer, were made profeffors of medicine; the profefforfhip of materia medica and botany, which Dr Alfton then held, having been added to the univerfity many years before. Immediately after thefe gentlemen were elected profeffors, they began to deliver regular courfes of lectures on the different branches of medicine, and they and their fucceffors have uniformly continued fo to do every winter.

Monro.

The plan for a medical education at Edinburgh was ftill incomplete without an hofpital, where ftudents could fee the practice of phyfic and furgery, as well as hear the lectures of the profeffors. A fcheme was therefore propofed by Dr Monro's father, and others, particularly the members of the royal college of phyficians and board of furgeons, for raifing by fubfcription a fund for building and fupporting an hofpital for the reception of difeafed poor; and our author publifhed a pamphlet fetting forth the advantages that would attend fuch an inftitution. In a fhort time a confiderable fum of money was raifed, a fmall houfe was fitted up, and patients were admitted into it, and regularly attended by many of the phyficians and furgeons in town. The fund for this charity increafing very confiderably, in a great meafure from the activity and influence of that very worthy citizen and magiftrate George Drummond, Efq. the foundation was laid of the prefent large, commodious, and ufeful hofpital, the *Royal Infirmary;* in the planning of which Dr Monro fuggefted many ufeful hints, and in particular the elegant room for chirurgical operations was defigned and executed under his direction. Provoft Drummond and he were nominated the building committee; and the fabric was entirely completed in a fhort fpace of time. It has fince been fo largely endowed, as to be capable of receiving a great number of difeafed poor, whofe cafes the ftudents of phyfic and furgery have an opportunity of feeing daily treated with the greateft attention and care by phyficians and furgeons eminent in their profeffion; and a regifter of the particulars of all the cafes which have been received into the houfe fince its firft opening has been kept, in books appropriated for that purpofe, for the ufe of the ftudents.

In order to make the hofpital of ftill further ufe to the ftudents, Dr Monro frequently, while he continued profeffor of anatomy, gave lectures on the chirurgical cafes; and the late judicious phyfician, Dr Rutherford profeffor of the practice of phyfic, began, in the year 1748, to deliver clinical lectures, to be continued every winter, on the moft remarkable cafes in the hofpital.

Doctor Monro, though he was elected profeffor of anatomy in the year 1721, was not received into the univerfity till the year 1725, when he was inducted along with that great mathematician the late Mr Colin Maclaurin, with whom he ever lived in the ftricteft friendfhip. From this time he regularly every winter gave a courfe of lectures on anatomy and furgery, from October to May, upon a moft judicious and comprehenfive plan: A tafk in which he perfevered with the greateft affiduity, and without the leaft interruption, for near forty years; and fo great was the reputation he had acquired, that ftudents flocked to him from the moft diftant corners of his majefty's dominions.

In

In 1759, our profeffor entirely relinquifhed the bufinefs of the anatomical theatre to his fon Dr Alexander, who had returned from abroad, and had affifted him in the courfe of lectures the preceding year. But after this refignation, he ftill endeavoured to render his labours ufeful to mankind, by reading clinical lectures at the hofpital for the improvement of the ftudents; of which Dr Duncan, who was one of his pupils, has given the following acccount. " There I had myfelf the happinefs of being a pupil, who profited by the judicious conduct of his practice, and was improved by the wifdom and acutenefs of his remarks. I have indeed to regret that I attended only the laft courfe of his lectures in which he had ever a fhare, and at a time when he was fubjected to a difeafe which proved at length fatal. Still, however, from what I faw and from what I heard, I can venture to affert, that it is hardly poffible to conceive a phyfician more attentive to practice, or a preceptor more anxious to communicate inftructions. His humanity, in the former of thefe characters, led him to beftow the moft anxious care on his patients while they were alive; and his zeal in the latter induced him to make them the fubject of ufeful leffons when they happened to die.——In the different ftations of phyfician, of lecturer, and of manager in the hofpital, he took every meafure for inquiring into the caufes of difeafes by diffection. He perfonally attended the opening of every body; and he not only dictated to the ftudents an accurate report of the diffection, but with nice difcrimination contrafted the difeafed and found ftate of every organ. Thus, in his own perfon, he afforded to the ftudents a confpicuous example of the advantages of early anatomical purfuits, as the happieft foundation for a medical fuperftructure. His being at once engaged in two departments, the anatomical theatre and clinical chair, furnifhed him with opportunities both on the dead and living body, and placed him in the moft favourable fituation for the improvement of medicine; and from thefe opportunities he derived every poffible advantage which they could afford."

His father, old Mr Monro, lived to an advanced age; and enjoyed the unfpeakable pleafure of beholding a fon, efteemed and regarded by mankind, the principal actor in the execution of his favourite plan, the great object of his life, the founding a feminary of medical education in his native country: The fon, who furvived him near 30 years, had the fatisfaction to behold this feminary of medical education frequented yearly by 300 or 400 ftudents, many of whom came from the moft diftant corners of his majefty's dominions, and to fee it arrive to a degree of reputation far beyond his moft fanguine hopes, being equalled by few, and inferior to none, in Europe.

Few men were members of more focieties than Dr Monro; ftill fewer equally affiduous in their attendance of thofe which in any way tended to promote public utility. He was a manager of many public charities; and not only a member of different medical focieties, but likewife of feveral others inftituted for promoting literature, arts, fciences, and manufactures in Scotland, and was one of their moft ufeful members. While he was held in high eftimation at home, he was equally efteemed and refpected abroad, and was elected member of the royal fociety of London, and an honorary member of the royal academy of furgery at Paris.

He was not only very active in the line of his own profeffion, but as a citizen and general member of the community; for, after he had refigned the anatomical chair to his fon, he executed with the ftricteft punctuality the duties of feveral engagements both of a civil and political nature: He was a director of the Bank of Scotland, a Juftice of the Peace, a Commiffioner of High-roads, &c.

At length, after a life fpent in the moft active induftry, he became afflicted with a tedious and painful difeafe, which he bore with equal courage and refignation till his death, which happened on July 10th 1767, in the 70th year of his age.

Dr Monro was a man of great humanity and fweetnefs of temper, and endowed with a fingular liberality of fentiment. He was a fincere friend, and an agreeable companion; an affectionate hufband, and a kind father; and was never more happy than when he could ferve thofe whom he thought deferving.

Of his works, the firft in order is his Ofteology, which was written for the ufe of ftudents, but is capable alfo of affording inftruction to the oldeft and moft experienced practitioner; as, befides a minute defcription of the parts copied from nature, it every where abounds with new and important obfervations immediately applicable to practice. It has been tranflated into many different languages; has paffed through numerous editions; and has been reprinted in foreign countries in the moft fuperb manner, accompanied with elegant and mafterly engravings. His defcription of the Lacteal Sac and Thoracic Duct contains the moft accurate account of that important part of the body which has been yet publifhed; and his Anatomy of the Nerves will tranfmit to pofterity an excellent example of accurate diffection, faithful defcription, and ingenious reafoning. The fix volumes of Medical Effays and Obfervations, publifhed by a fociety in Edinburgh, are univerfally known and efteemed. To that fociety he was appointed fecretary; but, after the publication of the firft volume, to which he had largely contributed, the members growing remifs in their attendance, he became the fole collector and publifher of the work: To him we are therefore in a great meafure indebted for thofe numerous and important difcoveries with which this publication has enriched every department of medical knowledge. In the two firft volumes of the Phyfical and Literary Effays, publifhed by the phyfical fociety of Edinburgh, in which he had the rank of one of the prefidents, we find feveral papers written by him, which are not the leaft ornaments of that collection. His account of the Succefs of Inoculation in Scotland may be confidered as his laft publication: It demonftrates his extenfive correfpondence and indefatigable induftry, and has had great influence in promoting that falutary practice. Befides thefe, he was alfo the author of feveral other elegant and mafterly productions, which were either never publifhed, or were publifhed without his knowledge and from incorrect copies. A collection of all his works, properly arranged, corrected, and illuftrated with copperplates, has been publifhed by Dr Alexander Monro, his fon and fucceffor in the anatomical chair, in a fplendid quarto volume, printed for Elliot, Edinburgh, 1781; to which is prefixed a life of the author, by another of his fons, Dr Donald, phyfician in London. The obfervation of an excellent judge,

judge, the illuftrious Haller, concerning our author's Medical Effays and Obfervations, which now form a part of this collection, may with no lefs juftice be applied to the whole: It is a "book which ought to be in the poffeffion of every medical practitioner."

MONS, an ancient, large, handfome, rich, and very ftrong city of the Auftrian Netherlands, in Hainault. There is a chapter, confifting of 30 ladies of diftinction, who have the liberty of leaving the community when they intend to marry. They have feveral manufactures, and a good trade. It was taken by the allies in 1709, and by the French in July 1746; but rendered back by the treaty of Aix-la-Chapelle, after the fortifications were demolifhed. It ftands partly on a hill and partly on a plain, in a marfhy foil, on the rivers Haine and Trouillie, by which the country about it may be overflowed when they pleafe. E. Lon. 3. 39. N. Lat. 50. 25.

Mons *Sacer*, (anc. geog.), a mountain of the Sabines beyond the Anio, to the eaft of Rome; whither the common people retired once and again to avoid the tyranny of the patricians. From this fecefion, and the altar of *Jupiter Terribilis* erected there, the mountain took its name.

MONSEIGNEUR, "My lord;" a title of honour ufed by the French in writing or fpeaking to dukes, peers, archbifhops, bifhops, and prefidents à mortier. *Monfeigneur*, abfolutely ufed, is a title now reftrained to the dauphin of France; thus it is faid an officer belonging to *Monfeigneur:* but this cuftom was not introduced till the reign of Lewis XIV. the dauphin before that time being called *Monfieur le Dauphin.*

MONSIEUR, a title of civility ufed by the French, in fpeaking to or of their equals, or thofe that are but little below them. Thus a duke or a marquis, fpeaking to an equal or inferior, ufes the word *Monfieur;* and a mechanic fpeaking to a mechanic, gives him the fame title: but nobody calls the French king *Monfieur*, except the children of France The word is compounded of *mon*, "my," and *fieur*, "fir."

In France, the infcriptions of all letters run thus: *A monfieur monfieur* fuch-a-one. *Monfieur* abfolutely ufed, is a title given to the fecond fon of France, and to the king's brother.

MONSOON, in phyfiology, a fpecies of trade-wind in the Eaft Indies, which, for fix months, blows conftantly the fame way, and the contrary way the other fix months. See Wind.

MONSON (Sir William), a brave Englifh admiral, third fon of Sir John Monfon of South Carlton in Lincolnfhire, was born in 1569. He was employed in many expeditions againft the Spaniards in Queen Elizabeth's time, and was highly honoured; the queen knighted him for his fervices in the earl of Effex's expedition to Cadiz, where he affifted much by his wife and moderate counfel to the earl. Military men were no favourites with James I. therefore, on the death of the queen, he received no recompence or pay beyond the ordinary fervice in which he was engaged: neverthelefs, as admiral of the narrow feas, he fupported the honour of the Britifh flag againft the infant infolence of the Dutch ftates, of which he frequently complains in his Navy Tracts; and protected our trade againft the encroachments of France. He had the misfortune to fall into difgrace by his vigilance, and was imprifoned in the Tower through the refentment of fome powerful courtiers; yet he was difcharged, and wrote a vindication of his own conduct, intitled, "Concerning the infolencies of the Dutch, and a Juftification of Sir William Monfon." He fpent his latter days in peace and privacy, which he employed in digefting his Navy Tracts; and died in 1643. Part of thefe tracts were printed in 1682; and they were afterwards all included in Churchill's Collection of Voyages.

MONSTER; a birth or production of a living thing degenerating from the proper and ufual difpofition of parts in the fpecies it belongs to. As, when there are too many members, or too few; or fome of them are extravagantly out of proportion, either on the fide of defect or excefs. The word comes from the Latin *monftrum*, of *monftrando*, "fhewing." Whence alfo the box wherein relics were anciently kept to be fhewn, was called *monftrum.* Dugdale mentions an inventory of the church of York with this article, *Item unum monftrum cum offibus fancti Petri in Beryl, & crucifixo in fummitate.*

Ariftotle defines a monfter to be a defect of nature, when acting towards fome end, it cannot attain to it, by reafon fome of its principles are corrupted.

Monfters do not propagate their kind; for which reafon fome rank mules among the number of monfters; as alfo hermaphrodites.

Females which bring forth twins, are found moft liable to produce monfters. The reafon, probably, is owing to this; that though the twins are covered with one common chorion, yet they have each their feparate amnios, which, by their contiguity may chance to grow together, and fo occafion a confufion or blending of the parts. Hence fo many double creatures.

F. Malebranche accounts for the production of monfters in the animal-world, thus: The creator has eftablifhed fuch a communication between the feveral parts of his creation, that we are not only naturally led to imitate one another, i. e. have a difpofition to do the fame things and affume the fame manners with thofe with whom we converfe; but alfo have certain natural difpofitions which incline us to compaffion as well as imitation. Thefe things moft men feel, and are fenfible of; and therefore need not be proved. The animal-fpirits, then, are not only naturally carried into the refpective parts of the body to perform the fame actions and the fame motions which we fee others do, but alfo to receive in fome manner their wounds, and take part in their fufferings.

Experience tells us, that when we look attentively on any perfon feverely beaten, or that hath a large wound, ulcer, or the like, the fpirits immediately flow into thofe parts of our body which anfwer to thofe we fee fuffer in the other; unlefs their courfe be ftopped from fome other principle. This flux of fpirits is very fenfible in perfons of a delicate conftitution, who frequently fhudder, and find a kind of trembling in the body on thefe occafions; and this fympathy in bodies produces compaffion in the mind.

Now, it muft be obferved, that the view of a wound, &c. wounds the perfon who views it the more ftrongly and fenfibly, as the perfon is more weak and delicate; the fpirits making a ftronger impreffion on the fibres of a delicate body, than in thofe of a robuft one. Thus ftrong, vigorous men, &c. fee an execution without much concern, while women, &c. are ftruck with pity and horror. As to children ftill in their mother's

Monster. Montague. womb, the fibres of their flesh being incomparably finer than those in women, the course of the animal-spirits must necessarily produce much greater alterations.

These things being laid down, monsters are easily accounted for. Suppose, *v. gr.* a child born a fool, and with all its legs and arms broke in the same manner as those of criminals in some countries are; which case we choose to instance in, because we are told from Paris that such a monster was actually born there, and lived in one of their hospitals 20 years: the cause of this accident, according to the principles laid down, was, that the mother seeing a criminal executed, every stroke given to the poor man, struck forcibly the imagination of the woman; and, by a kind of counter-stroke, the tender and delicate brain of the child. Now, though the fibres of the woman's brain were strangely shaken by the violent flux of animal-spirits on this occasion, yet they had strength and consistence enough to prevent an entire disorder; whereas the fibres of the child's brain being unable to bear the shock of those spirits, were quite ruined, and the ravage was great enough to deprive him of reason all his lifetime.

Again; the view of the execution frighting the woman, the violent course of the animal-spirits was directed forcibly from the brain to all those parts of the body corresponding to the suffering parts of the criminal; and the same thing must happen in the child. But in regard the bones of the mother were strong enough to resist the impulse of those spirits, they were not damaged: And yet the rapid course of these spirits could easily overpower and break the tender and delicate fibres of the bones of the child; the bones being the last parts of the body that are formed, and having a very slender consistence while the child is yet in the womb.

To which it may be here added, that had the mother determined the course of these spirits towards some other part of her body by tickling or scratching herself vehemently, the child would not in all probability have had its bones broken; but the part answering that to which the motion of the spirits was determined, would have been the sufferer. Hence appears the reason, why women in the time of gestation, seeing persons, &c. marked in such a manner in the face, impress the same mark on the same parts of the child: and why, upon rubbing some hidden part of the body when startled at the sight of any thing or agitated with any extraordinary passion, the mark or impression is fixed on that hidden part rather than on the face of the child. From the principles here laid down, may most, if not all, the phenomena of monsters be easily accounted for.

MONTAGUE (Edward), earl of Sandwich, an illustrious Englishman, who shone from the age of 19, and united the qualifications of general, admiral, and statesman; yet there were strange inconsistencies in his character. He acted early against Charles I.; he persuaded Cromwell, whom it is said he admired, to take the crown; and he was zealous for the restoration of Charles II. All this is imputed to a fond and unaccountable passion which he had for royalty. Upon general Monk's coming into England, he sailed with the fleet to Holland, and soon after he had the honour to convoy his majesty to England. For this he was created knight of the garter; and on the 12th of July 1660 he was created baron Montague of St Neots in the county of Huntingdon, Viscount Hinchinbrooke in the same county, and earl of Sandwich in Kent, sworn one of his majesty's most honourable privy-council, made master of the king's wardrobe, admiral of the Narrow Seas, and lieutenant-admiral to the duke of York, as lord high admiral of England.

When the Dutch war broke out in 1664, and the duke of York took upon himself the command of a fleet as high-admiral, his lordship commanded the blue squadron, and by his industry and care abundance of the enemies ships were taken; and in the great battle fought on the third of June 1665, in which the Dutch lost admiral Opdam, and had 18 men of war taken and 14 destroyed, a large share of the honour of the victory was justly given to the conduct of the earl of Sandwich. On the return of the English navy, the command of the whole fleet was given to the earl of Sandwich, which he was ordered to put as speedily as possible in a condition to return to the coast of Holland. Accordingly the earl sailed on the fifth of July with 60 men of war to the Dutch coast; when finding that their East India and Smyrna fleets were to return home north about, he steered for the coast of Norway, and found they had taken shelter in the port of Bergen, where the fleet were attacked: but leaving them there, and sailing back towards the coast of Holland, he met with four Dutch East Indiamen, with several other merchant-ships, under a good convoy, and took eight men of war, two of their East India ships, and 20 sail of merchant-men; and a few days after, a part of the fleet falling in with 18 of the Hollanders, the greatest part of them were also taken, with four Dutch men of war, and above 1000 prisoners. On his return he was received by the king with distinguished marks of favour; and soon after, he was sent ambassador-extraordinary to the court of Madrid, to mediate a peace between the crowns of Spain and Portugal; when he had the happiness to conclude a peace between the two nations to their mutual satisfaction.

On the breaking out of the last Dutch war, his lordship went to sea with the duke of York, and commanded the blue squadron; the French admiral, count d'Estrees, commanding the white. The fleet was at sea in the beginning of the month of May, and coming to an anchor in Southwold-bay in order to take in water, we are told, that on the 27th many officers and seamen were permitted to go on shore, and were at Southwold, Dunwich, and Aldborough; when, the weather being hazy, the earl gave it as his opinion, that, the wind standing as it did, the fleet rode in danger of being surprised by the Dutch; and indeed, between two and three the next morning, they were informed of their approach, upon which his royal highness made the signal for weighing anchor. The blue squadron was out first, the red next, and the white was much a-stern. The earl of Sandwich in the Royal James, which carried 100 guns, began the fight, and fell furiously on the squadron of Van Ghent in order to give the rest of his fleet time to form; when captain Brakel, in the Great Holland, attacked the Royal James; but was soon disabled, as were several other men of war, and three fire-ships sunk. By this time most of his men were killed; and the hull of the Royal James was so pierced with shot, that it was impossible to carry her off. In this distress he might have been relieved

by

Montague. by his vice-admiral Sir Joſeph Jordan, had not that gentleman been more ſolicitous about aſſiſting the duke. When therefore he ſaw him ſail by, heedleſs of the condition in which he lay, he ſaid to thoſe who were about him, "There is nothing left for us now, but to defend the ſhip to the laſt man." Being at length grappled by a fourth fire-ſhip, he begged his captain Sir Richard Haddock, and all his ſervants, to get into the boat and ſave themſelves, which they did: yet ſome of the ſailors refuſed to quit the admiral, and ſtaying endeavoured to extinguiſh the fire, but in vain; the ſhip blew up about noon. His lordſhip's body was found about a fortnight after, and was interred with great ſtate in Henry VII.'s chapel.

We have of his lordſhip's writing, 1. The Art of Metals, in which is declared the manner of their generation, tranſlated from the Spaniſh of Albaro Alonzo Barba, 8vo. 2. Several letters during his embaſſy to Spain, publiſhed with Arlington's letters. 3. A letter to ſecretary Thurloe. 4. Original letters and negociations of Sir Richard Fanſhaw, the earl of Sandwich, the earl of Sunderland, and Sir William Godolphin, wherein divers matters between the three crowns of England, Spain, and Portugal, from the year 1663 to 1678, are ſet in a clear light, 2 vols 8vo.

MONTAGUE (Lady Mary Wortley,) eminent by her *Letters*, was daughter of the firſt duke of Kingſton, and died in 1762.

MONTAGUE (Edward Wortley), ſon of the former, paſſed through ſuch variegated ſcenes, that a bare recital of them would ſavour of the marvellous. From Weſtminſter ſchool, where he was placed for education, he ran away three ſeveral times. He exchanged clothes with a chimney-ſweeper, and he followed for ſome time that ſooty occupation. He next joined himſelf to a fiſherman, and cried flounders in Rotherhithe. He then ſailed as a cabin-boy to Spain; where he had no ſooner arrived, than he ran away from the veſſel, and hired himſelf to a driver of mules. After thus vagabondizing it for ſome time, he was diſcovered by the conſul, who returned him to his friends in England. They received him with a joy equal to that of the father of the prodigal ſon in the goſpel. A private tutor was employed to recover thoſe rudiments of learning which a life of diſſipation, of blackguardiſm, and of vulgarity, might have obliterated. Wortley was ſent to the Weſt-Indies, where he remained ſome time; then returned to England, acted according to the dignity of his birth, was choſen a member, and ſerved in two ſucceſſive parliaments. His expences exceeding his income, he became involved in debt, quitted his native country, and commenced that wandering traveller he continued to the time of his death. Having viſited moſt of the eaſtern countries, he contracted a partiality for their manners. He drank little wine; a great deal of coffee; wore a long beard; ſmoked much; and, even whilſt at Venice, he was habited in the eaſtern ſtyle. He ſat croſs-legged in the Turkiſh faſhion through choice. With the Hebrew, the Arabic, the Chaldaic, and the Perſian languages, he was as well acquainted as with his native tongue. He publiſhed ſeveral pieces. One on the "Riſe and Fall of the Roman Empire." Another an exploration of "The Cauſes of Earthquakes."—As this gentleman was remarkable for the uncommon incidents which attended his life, the cloſe of that life was no leſs marked with ſingularity. He had been early married to a woman, who aſpired to no higher a character than that of an induſtrious waſherwoman. As the marriage was ſolemnized in a frolic, Wortley never deemed her ſufficiently the wife of his boſom to cohabit with her. She was allowed a maintenance. She lived contented, and was too ſubmiſſive to be troubleſome on account of the conjugal rites. Mr Montague, on the other hand, was a perfect patriarch in his manners. He had wives of almoſt every nation. When he was with Ali Bey in Egypt, he had his houſehold of Egyptian females, each ſtriving who ſhould be the happy ſhe who could gain the greateſt aſcendency over this Anglo-Eaſtern baſhaw. At Conſtantinople, the Grecian women had charms to captivate this unſettled wanderer. In Spain a Spaniſh brunette, in Italy the olive-complexioned female, were ſolicited to partake the honours of the bridal-bed. It may be aſked what became of this group of wives? Mr Montague was continually ſhifting the place, and conſequently varying the ſcene. Did he travel with his wives, as the patriarchs did with their flocks and herds? No ſuch thing. Wortley, conſidering his wives as bad travelling companions, generally left them behind him. It happened, however, that news reached his ears of the death of the original Mrs Montague the waſherwoman. Wortley had no iſſue by her; and without iſſue male, a very large eſtate would revert to the ſecond ſon of lord Bute. Wortley, owing the family no obligations, was determined, if poſſible, to defeat their expectations. He reſolved to return to England and marry. He acquainted a friend with his intentions, and he commiſſioned that friend to advertiſe for any young decent woman who might be in a pregnant ſtate. Several ladies anſwered it. One out of the number was ſelected, as being the moſt eligible object. She waited with eagerneſs for the arrival of her expected bridegroom; but, behold, whilſt he was on his journey, death very impertinently arreſted him in his career.

MONTAGUE (Charles), earl of Halifax, fourth ſon of George Montague of Harton in Northamptonſhire, Eſq; ſon of Henry the firſt earl of Mancheſter, was born in 1661. He was educated at Weſtminſter-ſchool and Cambridge, ſhewed very early a moſt pregnant genius, and quickly made great progreſs in learning. In 1684, he wrote a poem on the death of king Charles II. in which he diſplayed his genius to ſuch advantage, that he was invited to London by the earl of Dorſet; and upon his coming thither he ſoon increaſed his fame, particularly by a piece which he wrote in conjunction with Prior, publiſhed at London in 1687, under the title of *The Hind and the Panther tranſverſed to the Story of the Country-mouſe and the City-mouſe*. Upon the abdication of king James II. he was choſen one of the members of the convention, and recommended by the earl of Dorſet to king William, who immediately allowed him a penſion of 500 l. *per annum*. Having given proofs of his great abilities in the houſe of commons, he was made one of the commiſſioners of the treaſury, and ſoon after chancellor of the exchequer; in which poſt he brought about that great work of recoining all the current money of the nation. In 1698, he was appointed firſt commiſſioner of the treaſury; and in 1679, was created a peer of England, by the title of *Baron Halifax* in the county of

of York. In 1701, the houfe of commons impeached him of fix articles, which were difmiffed by the houfe of Lords. He was attacked again by the houfe of commons in 1702, but without fuccefs. In 1705, he wrote, An anfwer to Mr Bromley's fpeech in relation to the occafional Conformity-bill. In 1706, he was one of the commiffioners for the union with Scotland; and upon paffing the bill for the naturalization of the illuftrious houfe of Hanover, and for the better fecurity of the fucceffion of the crown in the Proteftant line, he was made choice of to carry that act to Hanover. Upon the death of Queen Anne, when the king had taken poffeffion of his throne, his lordfhip was appointed firft commiffioner of the treafury, and created earl of Halifax and knight of the garter. He died in 1715. His lordfhipfhip wrote feveral other pieces befides thofe abovementioned; all which, with fome of his Speeches, were publifhed together in 1716, in an octavo volume.

MONTAIGNE (Michael de), a French gentleman, was born in Perigord in 1533. His father educated him with great care, and made him learn Latin as other children learn their mother-tongue. His tutors were Nicholas Gronchi, who wrote *De Comitiis Romanorum;* William Guerenti, who wrote on Ariftotle; George Buchanan; and M. Anthony Muret. He was alfo taught Greek by way of recreation; and becaufe fome think that ftarting children out of their fleep fpoils their underftanding, he was awakened every morning with the found of mufic. He was counfellor for a while in the parliament of Bourdeaux; afterwards made mayor of Bourdeaux. He publifhed his *Effays*, fo much known in the world, in 1580. Montaigne had a great deal of wit and fubtlety, but no fmall fhare of conceit and vanity. The learned and ingenious are much divided in their opinion about his works. He died in 1592.

MONTANISTS, Chriftian heretics, who fprung up about the year 171, in the reign of the emperor Marcus Aurelius. They were fo called from their leader, the herefiarch Montanus, a Phrygian by birth; whence they are fometimes ftyled *Phrygians* and *Cataphrygians*.

Montanus, it is faid, embraced Chriftianity in hopes of rifing to the dignities of the church. He pretended to infpiration; and gave out, that the Holy Ghoft had inftructed him in feveral points, which had not been revealed to the apoftles. Prifcilla and Maximilla, two enthufiaftic women of Phrygia, prefently became his difciples; and in a fhort time he had a great number of followers. The bifhops of Afia, being affembled together, condemned his prophecies, and excommunicated thofe who difperfed them. Afterwards they wrote an account of what had paffed to the weftern churches, where the pretended prophecies of Montanus and his followers were likewife condemned.

The Montanifts, finding themfelves expofed to the cenfure of the whole church, formed a fchifm, and fet up a diftinct fociety under the direction of thofe who called themfelves *prophets*. Montanus, in conjunction with Prifcilla and Maximilla, was at the head of the fect.

Thefe fectaries made no alteration in the creed. They only held, that the Holy Spirit made Montanus his organ for delivering a more perfect form of difcipline than what was delivered by the apoftles. They refufed communion for ever to thofe who were guilty of notorious crimes, and believed that the bifhops had no authority to reconcile them. They held it unlawful to fly in time of perfecution. They condemned fecond marriages, allowed the diffolution of marriage, and obferved three lents.

The Montanifts became feparated into two branches; one of which were the difciples of Proclus, and the other of Æfchines. The latter are charged with following the heterodoxy of Praxeas and Sabellius concerning the Trinity.

MONTANUS (Benedict Arias), a moft learned Spanifh theologian, born in the diocefe of Badajox, about the year 1528. He affifted at the council of Trent with great reputation; and his merit and writings recommended him to Philip II. of Spain, who employed him in publifhing a new polyglot bible after the Complutenfian edition, which was printed by the care of cardinal Ximenes. This bible was printed at Antwerp, whither Montanus went in 1571; and on his return to Spain he refufed the bifhopric which Philip offered him for his reward, but fpent the reft of his days at Sevilla, where he died about the year 1598. Montanus had not only vaft erudition, but great good fenfe; he loved folitude, was very laborious, never drank wine, and feldom ate flefh.

MONTECUCULI (Raymond de), generaliffimo of the emperor's army, and one of the greateft commanders of his time, was born in the duchy of Modena, of a diftinguifhed family in 1608. Erneft Montecuculi his uncle, who was general of the artillery in the Imperial army, refolved that he fhould ferve firft as a common foldier, and that he fhould pafs through all the military degrees, before he was raifed to command. This the young Montecuculi did with applaufe. In 1644, when he was at the head of 2000 horfe, he furprifed by a precipitate march 10,000 Swedes, who laid fiege to Nemeffau in Silefia, and obliged them to abandon their artillery and baggage; but a fhort time after, he was defeated and taken prifoner by the general Banier. Having obtained his liberty at the end of two years, he joined his troops to thofe of John de Wert; and defeated general Wrangel in Bohemia, who was killed in the battle. In 1657, the emperor made him general marfhal de camp; and fent him to the affiftance of John Cafimir, king of Poland. Montecuculi vanquifhed Ragotzi prince of Tranfilvania, drove out the Swedes, and diftinguifhed himfelf in an extraordinary manner againft the Turks in Tranfilvania and Hungary. In 1673, he commanded the Imperial army againft the French, and took Bonne; he then proceeded with feint marches in order to deceive Turenne, in which he obtained great honour. However, the command of that army was taken from him the next year; but it was reftored to him in 1675, in order that he might make head againft the great Turenne. All Europe had their eyes fixed on thefe two able warriors, who then made ufe of all the ftratagems which genius and military knowledge were capable of fuggefting. The marfhal de Turenne was obtaining the fuperiority, when he was taken off by a cannon-ball. Montecuculi wept at the death of fo formidable an enemy, and beftowed upon him the greateft praifes. The great prince of Conde was the only French general that could deprive Montecuculi of the fuperiority he had obtained by Turenne's death. That prince was

was therefore fent to the Rhine, and ftopped the Imperial general; who confidered this laft campaign as the moft glorious of his life, not for his being conqueror, but for his not being conquered, when he was oppofed by a Turenne and a Conde. He fpent the reft of his life at the Imperial court; and died at Lintz, in 1680. He wrote *Memoirs;* the beft edition of which is that of Strafburg, in 1735.

MONTESQUIEU (Charles de Secondat) baron, a moft illuftrious Frenchman defcended from an ancient and noble family of Guienne, was born at the caftle of La Brede, near Bourdeaux, in 1689. The greateft care was taken of his education; and at the age of 20 he had actually prepared materials for his *Spirit of Laws*, by well-digefted extracts from thofe immenfe volumes of civil law which he had ftudied, not barely as a civilian, but as a philofopher. He became a counfellor of the parliament of Bourdeaux in 1714, and was received prefident à mortier two years after. In 1721 he publifhed his *Perfian Letters;* in which, under the fcreen of Oriental manners, he fatirized thofe of France, and treated of feveral important fubjects by delicate tranfient glances: he did not avow this publication; but was no fooner pointed out as the author, than zeal without knowledge, and envy under the mafk of it, united at once againft the Perfian Letters. He was received into the French academy in 1728; and having previoufly quitted his civil employments, he entirely devoted himfelf to his genius, and was no longer a magiftrate but a man of letters. Having thus fet himfelf at liberty, he travelled through Germany, Italy, Switzerland, Holland, and England, in which laft country he refided three years, and contracted intimacies with the greateft men then alive; for Locke and Newton were dead. The refult of his obfervations was, "that Germany was fit to travel in, Italy to fojourn in, England to think in, and France to live in." On his return he retired for two years to his eftate at La Brede, where he finifhed his work *On the Caufes of the Grandeur and Declenfion of the Romans;* which appeared in 1734. The reputation acquired by this laft work only cleared the way for his greater undertaking, the *Spirit of Laws*, which was printed at Geneva in 2 vols 4to. 1750. This was immediately attacked by the adverfaries of his Perfian Letters, in a multitude of anonymous pamphlets; containing all the reproaches to which a liberal mind is expofed from craft and ignorance. M. Montefquieu drew up a defence of this work; which, for truth, moderation, and delicacy of ridicule, may be regarded as a model in its way. This great man was peaceably enjoying that fulnefs of efteem which his great merits had procured him, when he fell fick at Paris, and died on the 10th of February 1755.—The following character of this great man is drawn by Lord Chefterfield. "His virtues did honour to human nature, his writings juftice. A friend to mankind, he afferted their undoubted and unalienable rights with freedom, even in his own country; whofe prejudices in matters of religion and government he had long lamented, and endeavoured, not without fome fuccefs, to remove. He well knew, and juftly admired, the happy conftitution of this country, where fixed and known laws equally reftrain monarchy from tyranny, and liberty from licentioufnefs. His works will illuftrate his name, and furvive him, as long as right reafon, moral obligation, and the true fpirit of laws, fhall be underftood, refpected, and maintained."—As to his perfonal qualities, we are told by his elogift M. d'Alembert, that "he was of a fweet, gay, and even temper. His converfation was fpirited, agreeable, and inftructive. Nobody told a ftory in a more lively manner, or with more grace and lefs affectation. He had frequent abfence of mind; but always awaked from it by fome unexpected ftroke that re-animated the languifhing converfation. Tho' he lived with the great, he retired whenever he could to his eftate in the country, and there met his books, his philofophy, and his repofe. Surrounded at his leifure-hours with peafants, after having ftudied man in the commerce of the world, he ftudied him in thofe fimple people folely inftructed by nature. With them he cheerfully converfed; he endeavoured, like Socrates, to find out their genius, and appeared as happy with them as in the moft brilliant affemblies; efpecially when he reconciled their differences, and by his beneficence relieved them from their diftreffes."

Befides the works already mentioned, M. Montefquieu wrote feveral fmall pieces, as the Temple of Gnidus, Lyfimachus, and Effay upon Tafte, which is left unfinifhed. His works have been collected fince his death, and printed at Paris in a fplendid edition, in quarto. They have likewife all of them been tranflated into Englifh.

MONTFAUCON (Bernard de), a very learned Benedictine of the congregation of St Maur, fingularly famous for his knowledge in Pagan and ecclefiaftical antiquities, was born of an ancient and noble family in Languedoc, in 1655. He ferved for fome time in the army; but the death of his parents mortified him fo with regard to the world, that he commenced Benedictine monk in 1675, and applied himfelf intenfely to ftudy. Though Montfaucon's life was long, healthy, retired, and laborious, his voluminous publications feem fufficiently to have employed the whole; exclufive of his greateft undertaking, for which he will be always memorable. This was his *Antiquité expliqué*, written in Latin and French, illuftrated with elegant plates, in 10 vols folio, to which he added a fupplement of 5 vols more. He died at the abbey of St Germain in 1741.

MONTFERRAT, a province of Italy, with the title of a duchy; bounded on the eaft by the duchy of Milan, and part of the territory of Genoa; on the north, by the Vercellefe and Canavefe; on the weft, by Piedmont properly fo called; and on the fouth by the territory of Genoa, from whence it is feparated by the Appennine mountains. It contains 200 towns and caftles; and is very fertile and well cultivated, abounding in corn, wine, oil, and filk. It belongs to the king of Sardinia. Cafal is the capital town.

MONTGOMERY, the capital of a county of the fame name in North Wales, took its name from Roger de Montgomery earl of Shrewfbury, who built the caftle; but it is called by the Welfh *Tre Valdwin*, that is, Baldwin's town; having been built by Baldwin, lieutenant of the marches of Wales, in the reign of William I. The Welfh, after having put the garrifon to the fword, demolifhed it in 1095; but Henry III. rebuilt it, and granted it the privileges of a free borough, with other liberties. It is a large and tolerably well built town, in a healthful fituation and fertile foil. It fends a member to parliament, and has the

the title of an earldom. It had also formerly a tower and castle; but they were demolished in the civil wars. W. Long. 3. 10. N. Lat. 52. 36.

MONTGOMERYSHIRE, a county of North Wales, 35 miles in length and 34 in breadth; bounded on the north by Merionethshire and Denbighshire, on the east by Shropshire, on the south by Radnor and Cardiganshires, and on the west by another part of Merionethshire. It contains about 34,000 inhabitants, and between 5000 and 6000 houses. The county is full of high hills, with a few valleys and meadows fit for corn and pasture. The air is sharp and cold on the mountains, but is more mild in the valleys.

MONTH, the twelfth part of a year. See ASTRONOMY, n° 136.

MONTMORENCY, a town of France, with the title of a duchy, remarkable for the tombs of the dukes of this name. It is seated on a hill, near a large valley, fertile in fruits, especially excellent cherries. E. Long. 2. 24. N. Lat. 48. 59.

MONTMORENCY (Anne de), a peer, marshal, and constable, of France, and one of the greatest generals of the 16th century, defended, in 1512, the city of Mezieres against the emperor Charles V. and obliged the count of Nassau to raise the siege. The following year he was made marshal of France; and in 1525 following king Francis I. into Italy, he was taken with that prince at the battle of Pavia, which was fought contrary to his advice. The important services he afterwards rendered the state were rewarded by the sword of constable of France, with which he was presented by the king on the 10th of February 1538. He afterwards underwent various revolutions of fortune both at court and in the field. At last, being wounded at the battle of St Denis, which he gained on the 10th of November 1567, he died of his wounds two days after, at 74 years of age. It is said, that a cordelier attempting to prepare him for death, when he was covered with blood and wounds, after the battle of St Denis, he replied in a firm and steady voice: "Do you think that a man who has lived near 80 years with honour, has not learnt to die for a quarter of an hour?"

MONTPELIER, one of the handsomest towns of France, and the most considerable in Languedoc excepting Tholouse, is situated in E. Long. 4. 20. N. Lat. 45. 58. It hath a citadel, a bishop's see, a famous university where the art of medicine is taught, a royal academy of sciences, and a mint. The streets are very narrow and crooked; but always clean, because lying on a descent. The inhabitants are reckoned about 30,000 in number, among whom are a great number of physicians and apothecaries. This place is celebrated for its medicinal compositions, which are distributed all over Europe; particularly Hungary-water, oil of lavender, syrup of capillaire, essences, and perfumes. The air is extremely healthy, for which reason valetudinarians come hither from all parts for their recovery. It is seated on a hill, on the river Merdanson, which passes into several parts of the town through subterranean vaults.

MONT-REAL, an island of North America, in the river St Lawrence, about 28 miles long and 10 broad. The soil is very fertile, and the air wholesome. It belonged to the French; but was taken by the generals Amherst and Murray on the 8th of September 1760, without firing a gun. According to the terms of capitulation, all the French forces were to be sent to Old France; and, consequently, all Canada became subject to the crown of Great Britain: this cession was confirmed by the peace of 1763. The town is pretty well fortified; and has a pleasant situation, with wide open streets. It is built on the side of the river, from whence there is a gradual easy ascent to what is called the *Upper Town*. The Hôtel Dieu, the magazines, and the place of arms, are in the Lower Town; which is also the residence of the merchants. The seminary or school, the parish-church, the monks called *Recolets*, the Jesuits, and the nuns, are in the Upper; where likewise the late governor, and most of the officers, resided. There are also a general hospital, and a church belonging to the Jesuits, which is large and well-built. The inhabitants carry on a trade with the savages in skins and furs. It is 120 miles south-west of Quebec, and 110 north of Albany. W. Long. 72. 4. N. Lat. 45 35.

MONTROSE, a handsome town of North Britain, in the shire of Angus, situated at the mouth of the river Esk, on the German Ocean, 46 miles north-east of Edinburgh.

Steel spaws are very numerous in the country round Montrose. Besides these, there is a well near this town, whose water is of a whitish colour, soft taste, and faintly discovering a mineral quality, and is of a different nature from the steel one. It is universally diuretic; and has been found useful in stranguries, scorbutic disorders, flatulencies, &c.

MONTROSE (Marquis of). See GRAHAM; and BRITAIN, n° 137, 138, 143, 165.

MONTSERRAT, an high mountain of Spain, in Catalonia, on which is a famous monastery and chapel, dedicated to the Virgin Mary, whose image is said to perform many miracles; so that numbers of pilgrims resort hither. It is inhabited by monks of several nations, who entertain all that come out of devotion or curiosity, for three days gratis. This mountain is said to be 10 miles in circumference, and five high, from the top of which there is a view of the country to the distance of 150 miles. It is 25 miles N. W. of Barcelona. E. Long 2. 35. N. Lat. 41. 40.

MONTSERRAT, one of the Caribbee Isles belonging to Great Britain. It is a very small, but very pleasant island, so called by Columbus from its resemblance to a famous mountain near Barcelona in Catalonia. It lies in W. Long. 61. 0. N. Lat. 16. 50. having Antigua to the north-east, St Christopher's and Nevis to the north-west, and Guadaloupe lying south south-east at the distance of about nine leagues. In its figure it is nearly round, about nine miles in extent every way, 27 in circumference, and is supposed to contain about 40,000 or 50,000 acres. The climate is warm, but less so than in Antigua, and is esteemed very healthy. The soil is mountainous, but with pleasant valleys, rich and fertile, between them; the hills are covered with cedars and other fine trees. Here are all the animals as well as vegetables and fruits that are to be found in the other islands, and not at all inferior them in quality. The inhabitants raised formerly a considerable quantity of indigo, which was none of the best, but which they cut four times a-year. The present product is cotton, rum, and sugar. There is no good harbour, but three tolerable

lerable roads at Plymouth, Old Harbour, and Ker's-bay, where they ſhip the produce of the iſland. Public affairs are adminiſtered here as in the other iſles, by a lieutenant-governor, council, and aſſembly, compoſed of no more than eight members, two from each of the four diſtricts into which it is divided. The wonderful effects of induſtry and experience in meliorating the gifts of nature have been no where more conſpicuous than in theſe iſlands, and particularly in this, by gradually improving their produce, more eſpecially of late years, ſince the art of planting hath been reduced to a regular ſyſtem, and almoſt all the defects of ſoil ſo thoroughly removed by proper management and manure, that, except from the failure of ſeaſons, or the want of hands, there is ſeldom any fear of a crop. In 1770 there were exported from this iſland to Great Britain 167 bags of cotton, 1670l.; 740 hogſheads of rum, 7400l. To Ireland 133 ditto, 1330l.; 4338 hogſheads 232 tierces 202 barrels of ſugar, 79,507l.; in the whole 89,907l. To North America 12,633l. There are a few ſhips employed in trading to this iſland from London and from Briſtol. As to the number of inhabitants, according to the moſt probable accounts, they conſiſt of between 1200 and 1500 whites, and from 10,000 to 12,000 negroes, tho' ſome ſay not ſo many.

MONUMENT, in architecture, a building deſtined to preſerve the memory, &c. of the perſon who raiſed it, or the perſon for whom it was raiſed; ſuch are a mauſoleum, a triumphal arch, a pyramid, &c.

MOOD, or Mode. See Mode.

Moods *of Syllogiſm*. See Logic, n° 85.

Mood, or *Mode*, in grammar, the different manner of conjugating verbs. See Grammar.

MOON, in aſtronomy. See Astronomy, *paſſim*.

Moon-*Wort* in botany. See Lunaria.

MOOR, in country affairs, denotes an unlimited tract of land, uſually over-run with heath.

Moor-*Cock*, or *Gor-cock*. See Tetrao.

Moor-*Stone*, a valuable ſtone, much uſed in the coarſer works of the preſent builders; being truly a white granite, of a marbly texture.

MOORE, or More, (Edward), a late ingenious writer, was bred a linen-draper, but quitted buſineſs to join the retinue of the muſes; and he certainly had a very happy and pleaſing talent for poetry. In his *Trial of Selim the Perſian*, he complimented lord Lyttelton in an elegant kind of panegyric, couched under the appearance of accuſation: and his *Fables for the female ſex*, for eaſy verſification, poignant ſatire, and ſtriking morals, approach nearer to the manner of Gay, than any other of the numerous imitations of that author. He wrote alſo three dramatic pieces; The Gameſter, a tragedy; The Foundling, and Gil Blas, comedies. The ſucceſs of theſe was not ſuch as they merited; the firſt of them having met with a cold reception, for no other apparent reaſon but becauſe it too nearly touched a favourite and faſhionable vice; and the ſecond having been condemned for its ſuppoſed reſemblance to Sir Richard Steele's *Conſcious Lovers*, but to which good judges have been inclined to give it greatly the preference. Mr Moore married a lady of the name of *Hamilton*, daughter to Mr Hamilton table-decker to the princeſſes; who had herſelf a very poetical turn, and has been ſaid to have aſſiſted him in the writing of his tragedy. One ſpecimen of her poetry, however, was handed about before their marriage, and has ſince appeared in print in different collections of ſongs, particularly in one called the *Goldfinch*. It was addreſſed to a daughter of the famous Stephen Duck; and begins with the following ſtanza:

> Would you think it, my Duck, for the fault I muſt own,
> Your Jenny, at laſt, is quite covetous grown:
> Tho' millions if Fortune ſhould laviſhly pour,
> I ſtill ſhou'd be wretched, if I had not More.

And after half a dozen ſtanzas more, in which, with great ingenuity and delicacy, and yet in a manner that expreſſes a ſincere affection, ſhe has quibbled on our author's name, ſhe concludes with the following lines:

> You will wonder, my girl, who this dear one can be,
> Whoſe merit can boaſt ſuch a conqueſt as me:
> But you ſhan't know his name, tho' I told you before,
> It begins with an M, but I dare not ſay More.

In the year 1753, Mr Moore commenced a weekly miſcellaneous paper, intitled *The World, by Adam Fitz-Adam*; in which undertaking he was aſſiſted by lord Cheſterfield with ſome eſſays. This paper was collected into volumes, and Mr Moore died ſoon after.

MOORING, the act of confining and ſecuring a ſhip in a particular ſtation, by chains or cables, which are either faſtened to the adjacent ſhore, or to anchors in the bottom.

A ſhip may be either moored by the head, or by the head and ſtern: that is to ſay, ſhe may be ſecured by anchors before her, without any behind; or ſhe may have anchors out, both before and behind her; or her cables may be attached to poſts, rings, or moorings, which anſwer the ſame purpoſe.

When a ſhip is moored by the head with her own anchors, they are diſpoſed according to the circumſtances of the place where ſhe lies, and the time ſhe is to continue therein. Thus wherever a tide ebbs and flows, it is uſual to carry one anchor out towards the flood, and another towards the ebb, particularly where there is little room to range about; and the anchors are laid in the ſame manner, if the veſſel is moored head and ſtern in the ſame place. The ſituation of the anchors, in a road or bay, is uſually oppoſed to the reigning winds, or thoſe which are moſt dangerous; ſo that the ſhip rides therein with the effort of both her cables. Thus if ſhe rides in a bay, or road, which is expoſed to a northerly wind and heavy ſea from the ſame quarter, the anchors paſſing from the oppoſite bows ought to lie eaſt and weſt from each other: hence both the cables will retain the ſhip in her ſtation with equal effort againſt the action of the wind and ſea.

MOOSE, or Elk. See Cervus.

MOOT, a difficult caſe argued by the young barriſters and ſtudents at the inns of court, by way of exerciſe, the better to qualify them for practice, and to defend the cauſes of their clients. This, which is called *mooting*, is the chief exerciſe of the inns of court. Particular times are appointed for the arguing moot-caſes: the place where this exerciſe is performed was anciently called *moot-hall;* and there is a bailiff, or ſurveyor of the moots, annually choſen by the bench, to appoint the moot-men for the inns of chancery, and to keep an account of the performance of exerciſes.—The word is formed either from the Saxon *metan*, *gemetan*, "meeting;" or from the French *mot*, "word."

MORAL PHILOSOPHY, OR MORALS.

MORAL PHILOSOPHY is "The ſcience of MANNERS or DUTY; which it traces from man's "nature and condition, and ſhews to terminate in his "happineſs." In other words, it is "The knowledge "of our DUTY and FELICITY;" or, "The art of being VIRTUOUS and HAPPY."

It is denominated an *art*, as it contains a ſyſtem of rules for becoming virtuous and happy. Whoever practiſes theſe rules, attains an habitual power or facility of becoming virtuous and happy. It is likewiſe called a *ſcience*, as it deduces thoſe rules from the principles and conncteions of our nature, and proves that the obſervance of them is productive of our happineſs.

It is an art, and a ſcience, of the higheſt dignity, importance, and uſe. Its object is man's duty, or his conduct in the ſeveral moral capacities and connections which he ſuſtains. Its office is to direct that conduct; to ſhew whence our obligations ariſe, and where they terminate. Its uſe, or end, is the attainment of happineſs; and the means it employs are rules for the right conduct of our moral powers.

Moral Philoſophy has this in common with Natural Philoſophy, that it appeals to nature or fact; depends on obſervation; and builds its reaſonings on plain uncontroverted experiments, or upon the fulleſt induction of particulars of which the ſubject will admit. We muſt obſerve, in both theſe ſciences, how nature is affected, and what her conduct is in ſuch and ſuch circumſtances. Or, in other words, we muſt collect the appearances of nature in any given inſtance; trace theſe to ſome general principles, or laws of operation; and then apply theſe principles or laws to the explaining of other phænomena.

Therefore Moral Philoſophy inquires, not how man might have been, but how he is, conſtituted: not into what principles or diſpoſitions his actions may be artfully reſolved; but from what principles and diſpoſitions they actually flow: not what he may, by education, habit, or foreign influence, come to be, or do; but what, by his nature, or original conſtituent principles, he is formed to be and do. We diſcover the office, uſe, or deſtination of any work, whether natural or artificial, by obſerving its ſtructure, the parts of which it conſiſts, their connection or joint action. It is thus we underſtand the office and uſe of a watch, a plant, an eye, or hand. It is the ſame with a living creature, of the rational, or brute kind. Therefore, to determine the office, duty, or deſtination of man; or, in other words, what his buſineſs is, or what conduct he is obliged to purſue; we muſt inſpect his conſtitution, take every part to pieces, examine their mutual relations one to the other, and the common effort or tendency of the whole.

PART I.

CHAP. I.

Of MAN *and his* CONNECTIONS.

1 Man's infant ſtate. MAN is born a weak, helpleſs, delicate creature, unprovided with food, cloathing, and whatever elſe is neceſſary for ſubſiſtence or defence. And yet, expoſed as the infant is to numberleſs wants and dangers, he is utterly incapable of ſupplying the *former*, or ſecuring himſelf againſt the *latter*. But, though thus feeble and expoſed, he finds immediate and ſure reſources in the *affection* and *care* of his parents, who refuſe no labours, and forego no dangers, to nurſe and rear up the tender babe. By theſe powerful inſtincts, as by ſome mighty chain, does nature link the *parent* to the *child*, and form the ſtrongeſt *moral connection* on his part, before the child has the leaſt apprehenſion of it. *Hunger* and *thirſt*, with all the ſenſations that accompany or are connected with them, explain themſelves by a language ſtrongly expreſſive, and irreſiſtibly moving. As the ſeveral ſenſes bring in notices and informations of ſurrounding objects, we may perceive in the young ſpectator early ſigns of a growing *wonder* and *admiration*. Bright objects and ſtriking ſounds are beheld and heard with a ſort of commotion and ſurpriſe. But, without reſting on any, he eagerly paſſes on from object to object, ſtill pleaſed with whatever is moſt new. Thus the *love* of *novelty* is formed, and the paſſion of *wonder* kept awake. By degrees he comes acquainted with the moſt familiar objects, his parents, his brethren, and thoſe of the family who are moſt converſant with him. He contracts a *fondneſs* for them, is uneaſy when they are gone, and charmed to ſee them again. Theſe feelings become the foundation of a *moral attachment* on his ſide, and by this reciprocal ſympathy he forms the domeſtic alliance with his parents, brethren, and other members of the family. Hence he becomes intereſted in their concerns, and feels *joy* or *grief*, *hope* or *fear*, on their account, as well as his own. As his affections now point beyond himſelf to others, he is denominated a *good* or *ill* creature, as he ſtands *well* or *ill affected* to them. Theſe then are the firſt links of the *moral chain*, the early rudiments, or outlines of his character, his firſt rude eſſays towards agency, freedom, manhood.

When he begins to make excurſions from the nurſery, and extends his acquaintance abroad, he forms 2 His childhood. a little circle of companions, engages with them in play, or in queſt of adventures, and leads, or is led by them, as his genius is more or leſs aſpiring. Tho' this is properly the ſeaſon in which *appetite* and *paſſion* have the *aſcendant*, yet his *imagination* and *intellectual* powers open apace; and as the various images of things paſs before the mental eye, he forms variety

riety of taſtes; reliſhes ſome things, and diſlikes others, as his parents, companions, and a thouſand other circumſtances, lead him to combine agreeable or diſagreeable ſets of ideas, or repreſent to him objects in alluring or odious lights.

As his views are enlarged, his *active* and *ſocial* powers expand themſelves in proportion; the *love of action*, of *imitation*, and of *praiſe*, *emulation*, *curioſity*, *docility*, *a paſſion for command*, and *fondneſs of change*. His paſſions are quick, variable, and pliant to every impreſſion; his attachments and diſguſts quickly ſucceed each other. He compares things, diſtinguiſhes actions, judges of characters, and loves or hates them, as they appear well or ill affected to himſelf, or to thoſe he holds dear. Mean while he ſoon grows ſenſible of the conſequences of his own actions, as they attract applauſe, or bring contempt; he triumphs in the former, and is aſhamed of the latter; wants to hide them, and bluſhes when they are diſcovered. By means of theſe powers he becomes a fit ſubject of culture, the moral tie is drawn cloſer, he feels that he is accountable for his conduct to others as well as to himſelf, and thus is gradually ripening for ſociety and action.

3 His youth. As man advances from *childhood* to *youth*, his paſſions as well as perceptions take a more extenſive range. New ſenſes of pleaſure invite him to new purſuits; he grows ſenſible to the attractions of beauty, feels a peculiar ſympathy with the ſex, and forms a more tender kind of attachment than he has yet experienced. This becomes the cement of a *new moral relation*, and gives a ſofter turn to his paſſions and behaviour. In this turbulent period he enters more deeply into a *reliſh of friendſhip*, *company*, *exerciſes*, and *diverſions*; the *love of truth*, of *imitation*, and of *deſign*, grows upon him; and as his connections ſpread among his neighbours, fellow-citizens, and country-men, his *thirſt of praiſe*, *emulation*, and *ſocial affections* grow more intenſe and active. Mean while, it is impoſſible for him to have lived thus long without having become ſenſible of thoſe more auguſt ſignatures of order, wiſdom, and goodneſs, which are ſtamped on the viſible creation; and of thoſe ſtrong ſuggeſtions within himſelf of a parent-mind, the ſource of all intelligence and beauty; an object as well as ſource of that activity, and thoſe aſpirations which ſometimes rouſe his inmoſt frame, and carry him out of himſelf to an almighty and all-governing power: Hence ariſe thoſe ſentiments of *reverence*, and thoſe affections of *gratitude*, *reſignation*, and *love*, which link the ſoul with the Author of Nature, and form that moſt ſublime and god-like of all connections.

4 His manhood. Man having now reached his prime, either new paſſions ſucceed, or the old ſet are wound up to an higher pitch. For, growing more ſenſible of his connections with the public, and that particular community to which he more immediately belongs; and taking withal a larger proſpect of human life, and its various wants and enjoyments; he forms more intimate friendſhips, graſps at power, courts honour, lays down cooler plans of intereſt, and becomes more attentive to the concerns of ſociety; he enters into family connections, and indulges thoſe charities which ariſe from thence. The *reigning* paſſions of this period powerfully prompt him to provide for the decays of life; and in it *compaſſion* and *gratitude* exert their influence in urging the *man*, now in full vigour, to requite the affection and care of his parents, by ſupplying their wants and alleviating their infirmities.

5 Old age. At length human life verges downwards; and *old age* creeps on apace, with its *anxiety*, *love of eaſe*, *intereſtedneſs*, *fearfulneſs*, *foreſight*, and *love of offſpring*. The experience of the aged is formed to direct, and their coolneſs to temper, the heat of youth; the former teaches them to look back on paſt follies, and the latter to look forward into the conſequences of things, and provide againſt the worſt. Thus every age has its peculiar genius and ſet of paſſions correſponding to that period, and moſt conducive to the proſperity of the reſt. And thus are the *wants* of one period ſupplied by the *capacities* of another, and the *weakneſſes* of one age tally to the *paſſions* of another.

6 Paſſions of every age. Beſides theſe, there are other paſſions and affections of a leſs *ambulatory* nature, not peculiar to one period, but belonging to every age, and acting more or leſs in every breaſt throughout life. Such are *ſelf-love*, *benevolence*, *love of life*, *honour*, *ſhame*, *hope*, *fear*, *deſire*, *averſion*, *joy*, *ſorrow*, *anger*, and the like. The two firſt are affections of a cooler ſtrain, one pointing to the good of the individual, the other to that of the ſpecies; *joy* and *ſorrow*, *hope* and *fear*, ſeem to be only modifications, or different exertions, of the ſame *original* affections of *love* and *hatred*, *deſire* and *averſion*, ariſing from the different circumſtances or poſition of the object deſired or abhorred, as it is preſent or abſent. From theſe likewiſe ariſe other *ſecondary* or *occaſional* paſſions, which depend, as to ther exiſtence and ſeveral degrees, upon the original affections being gratified or diſappointed, as *anger*, *complacence*, *confidence*, *jealouſy*, *love*, *hatred*, *dejection*, *exaltation*, *contentment*, *diſguſt*, which do not form *leading* paſſions, but rather hold of them.

7 Their joint effects. By theſe ſimple but powerful ſprings, whether *periodical* or *fixed*, the life of man, weak and indigent as he is, is preſerved and ſecured, and the creature is prompted to a conſtant round of action, even to ſupply his own numerous and ever-returning *wants*, and to guard againſt the various *dangers* and *evils* to which he is obnoxious. By theſe links men are connected with each other, formed into families, drawn into particular communities, and all united as by a common league into one ſyſtem or body, whoſe members feel and ſympathize one with another. By this admirable adjuſtment of the conſtitution of *man* to his *ſtate*, and the gradual evolution of his powers, order is maintained, ſociety upheld, and human life filled with that variety of paſſion and action which at once enliven and diverſify it.

8 The directing power. This is a ſhort ſketch of the *principal movements* of the human mind. Yet, theſe movements are not the whole of man; they impel to action, but do not direct it; they need a *regulator* to guide their motions, to meaſure and apply their forces: and accordingly they have one that naturally *ſuperintends* and *directs* their action. We are conſcious of a principle within us, which examines, compares, and weighs things, notes the differences, obſerves the forces, and foreſees the conſequences of affections and actions. By this

this power we look back on paſt times, and forward into futurity, gather experiences, eſtimate the real and comparative value of objects, lay out ſchemes, contrive means to execute them, and ſettle the whole order and œconomy of life. This power we commonly diſtinguiſh by the name of *reaſon* or *reflection*, the buſineſs of which is not to ſuggeſt any original notices or ſenſations, but to canvaſs, range, and make deductions from them.

9 The judging or approving powers.

We are intimately conſcious of another principle within us, which approves of certain *ſentiments*, *paſſions*, and *actions*, and diſapproves of their contraries. In conſequence of the deciſions of this inward judge, we denominate ſome actions and principles of conduct *right*, *honeſt*, *good*; and others *wrong*, *diſhoneſt*, *ill*. The former excite our *eſteem*, *moral complacence*, and *affection*, immediately and originally of themſelves, without regard to their conſequences, and whether they affect our intereſt or not. The latter do as naturally and neceſſarily call forth our *contempt*, *ſcorn*, and *averſion*. That power by which we perceive this difference in affections and actions, and feel a conſequent reliſh or diſlike, is commonly called *conſcience* or the *moral ſenſe*. Whether ſuch a power belongs to human nature or not, muſt be referred to every one's experience of what paſſes within himſelf.

10 Theſe powers different from affections.

Theſe two powers of *reaſon* and *conſcience* are evidently principles different in *nature* and *kind* from the paſſions and affections. For the paſſions are mere *force* or *power*, *blind impulſes*, acting violently and without choice, and ultimately tending each to their reſpective objects, without regard to the intereſt of the others, or of the whole ſyſtem. Whereas the *directing* and *judging* powers diſtinguiſh and aſcertain the different forces, mutual proportions and relations, which the paſſions bear to each other and to the whole; recognize their ſeveral degrees of merit, and judge of the whole temper and conduct, as they reſpect either the individual or the ſpecies; and are capable of directing or reſtraining the blind impulſes of paſſion in a due conſiſtency one with the other, and a regular ſubordination to the whole ſyſtem.

11 Diviſion of the paſſions.

This is ſome account of the *conſtituent principles* of our nature, which, according to their different mixtures, degrees, and proportions, mould our character and ſway our conduct in life. In reviewing that large train of affections which fill up the different ſtages of human life, we perceive this obvious diſtinction among them; that ſome of them reſpect the *good* of the *individual*, and others carry us beyond ourſelves to the *good* of the *ſpecies* or *kind*. The former have therefore been called *private*, and the latter *public* affections. Of the firſt ſort are, *love of life*, of *pleaſure*, of *power*, and the like. Of the laſt are *compaſſion*, *gratitude*, *friendſhip*, *natural affection*, and the like. Of the *private* paſſions *, ſome reſpect merely the *ſecurity* and *defence* of the creature, ſuch as *reſentment*

12 Defenſive paſſions.

and *fear*; whereas others aim at ſome *poſitive* advantage or good, as *wealth*, *eaſe*, *fame*. The former ſort therefore, becauſe of this difference of objects, may be termed *defenſive* paſſions. Theſe anſwer to our *dangers*, and prompt us to avoid them if we can, or boldly to encounter them when we cannot.

13 Private or appetitive paſſions.

The other claſs of *private* paſſions, which purſue *private poſitive* good, may be called *appetitive*. However, we ſhall ſtill retain the name of *private*, in contradiſtinction to the *defenſive* paſſions. Man has a great variety of wants to ſupply, and is capable of many enjoyments, according to the ſeveral periods of his life, and the different ſituations in which he is placed. To theſe therefore a ſuitable train of *private* paſſions correſpond, which engage him in the purſuit of whatever is neceſſary for his ſubſiſtence or welfare.

14 Public paſſions.

Our *public* or *ſocial* affections are adapted to the ſeveral *ſocial connections* and *relations* which we bear to others, by making us ſenſible of their dangers, and intereſting us in their wants, and ſo prompting us to ſecure them againſt one and ſupply the other.

This is the firſt ſtep then to diſcover the *duty* and *deſtination* of man, the having analyſed the principles of which he is compoſed. It is neceſſary, in the next place, to conſider in what *order*, *proportion*, and *meaſure* of thoſe inward principles, *virtue*, or a ſound moral temper and right conduct conſiſts; that we may diſcover whence *moral obligation* ariſes.

CHAP. II.

Of DUTY, *or* MORAL OBLIGATION.

15 The meaſure of powers.

IT is by the end or deſign of any power or movement that we muſt direct its motions, and eſtimate the degree of force neceſſary to its juſt action. If it wants the force requiſite for the obtaining its end, we reckon it defective; if it has too much, ſo as to be carried beyond it, we ſay it is overcharged; and in either caſe it is imperfect and ill-contrived. If it has juſt enough to reach the ſcope, we eſteem it right and as it ſhould be. Let us apply this reaſoning to the paſſions.

16 Meaſure of the defenſive paſſions.

The *defence* and *ſecurity* of the individual being the *aim* of the *defenſive paſſions*, that *ſecurity* and *defence* muſt be the *meaſure* of their *ſtrength* or *indulgence*. If they are ſo *weak* as to prove inſufficient for that end, or if they *carry us beyond it*, i. e. raiſe unneceſſary commotions, or continue longer than is needful, they are unfit to anſwer their original deſign, and therefore are in an unſound and unnatural ſtate. The exerciſe of *fear* or of *reſentment* has nothing deſirable in it, nor can we give way to either without painful ſenſations. Without a certain degree of them, we are naked and expoſed. With too high a proportion of them, we are miſerable, and often injurious to others. Thus *cowardice* or *timidity*, which is the exceſs of fear, inſtead of ſaving us in danger, gives it too formidable an appearance, makes us incapable of attending to the beſt means of preſervation, and diſarms us of *courage*, our natural armour. *Fool-hardineſs*, which is the want of a due meaſure of *fear*, leads us heedleſsly into danger, and lulls us into a pernicious ſecurity. *Revenge*, i. e. *exceſſive reſentment*, by the violence of its commotion, robs us of that *preſence of mind* which is often the beſt guard againſt injury, and inclines us to purſue the aggreſſor with more ſeverity than ſelf-defence requires. *Puſillanimity*, or the want of a juſt indignation againſt wrong, leaves us quite unguarded, and tends to ſink the mind into a paſſive

* Here we uſe paſſions and affections without diſtinction. Their difference will be marked afterwards.

enervated tameneſs. Therefore " To keep the de-
" fenſive paſſions duly proportioned to our dangers, " is their natural pitch and tenor."

17 Meaſure of the private paſſions.

The *private* paſſions lead us to purſue ſome *poſitive* ſpecies of *private* good: that *good* therefore which is the object and end of each muſt be the *meaſure* of their reſpective force, and direct their operation. If they are too *weak* or *ſluggiſh* to engage us in the purſuit of their ſeveral objects, they are evidently *deficient*; but if they defeat their end by their *impetuoſity*, then are they ſtrained beyond the juſt tone of nature. Thus *vanity*, or an *exceſſive paſſion for applauſe*, betrays into ſuch meanneſſes and little arts of popularity as makes us forfeit the honour we ſo anxiouſly court. On the other hand, a *total indifference about the eſteem of mankind* removes a ſtrong guard and ſpur to virtue, and lays the mind open to the moſt abandoned proſecutions. Therefore, " to keep " our private paſſions and deſires proportioned to our " *wants*, is the juſt meaſure and pitch of this claſs of " affections."

18 Comparative force.

The *defenſive* and *private* paſſions do all agree in general, in their tendency or conduciveneſs to the intereſt or good of the individual. Therefore, when there is a colliſion of intereſt, as may ſometimes happen, that *aggregate of good* or *happineſs*, which is compoſed of the particular goods to which they reſpectively tend, muſt be the common ſtandard by which their *comparative degrees* of ſtrength are to be meaſured: that is to ſay, if any of them, in the degree in which they prevail, are incompatible with the greateſt aggregate of good or moſt extenſive intereſt of the individual, then are they unequal and diſproportionate. For, in judging of a particular *ſyſtem* or *conſtitution* of powers, we call that the *ſupreme* or *principal* end in which the aims of the ſeveral parts or powers coincide, and to which they are ſubordinate; and reckon them in due proportion to each other, and right with regard to the whole, when they maintain that ſubordination of ſubſerviency. Therefore, " To " proportion our defenſive and private paſſions in ſuch " meaſure to our dangers and wants as beſt to ſecure " the individual, and obtain the greateſt aggregate of " private good or happineſs, is their juſt balance or " comparative ſtandard in caſe of competition."

19 Meaſure of the public affections.

In like manner as the *public* or *ſocial* affections point at the good of others, that *good* muſt be the meaſure of their force. When a particular *ſocial* affection, as *gratitude* or *friendſhip*, which belongs to a particular *ſocial connection*, *viz*. that of a *benefactor* or of a *friend*, is too feeble to make us act the *grateful* or *friendly* part, that affection, being inſufficient to anſwer its end, is *defective* and *unſound*. If, on the other hand, a particular paſſion of this claſs counteract or defeat the intereſt it is deſigned to promote, by its violence or diſproportion, then is that paſſion *exceſſive* and *irregular*. Thus *natural affection*, if it degenerates into a *paſſionate* fondneſs, not only hinders the parents from judging coolly of the intereſt of their offspring, but often leads them into a moſt partial and pernicious indulgence.

20 Colliſion of ſocial affections.

As every kind affection points at the good of its particular object, it is poſſible there may be ſometimes a colliſion of intereſts or goods. Thus the regard due to a *friend* may interfere with that which we owe to a *community*. In ſuch a competition of intereſts, it is evident that the *greateſt* is to be choſen; and that is the greateſt intereſt which contains the greateſt ſum or aggregate of public good, greateſt in *quantity* as well as *duration*. This then is the *common ſtandard* by which the reſpective forces and ſubordinations of the ſocial affections muſt be adjuſted. *Therefore* we conclude, that " This claſs of affections are ſound and " regular when they prompt us to purſue the *intereſt* " of *individuals* in an intire conſiſtency with the *public good*," or, in other words, " When they are duly " proportioned to the *dangers* and *wants* of others, " and to the various *relations* in which we ſtand to " *individuals* or to *ſociety*."

Thus we have found, by an induction of particulars, the *natural pitch* or *tenor* of the *different orders of affection*, conſidered apart by themſelves. Now as the *virtue* or *perfection* of every creature lies in following its nature, or acting ſuitably to the juſt proportion and harmony of its ſeveral powers; therefore, " The VIRTUE of a creature endowed with ſuch " affections as *man* muſt conſiſt in obſerving or acting " agreeably to their *natural pitch and tenor*."

21 Balance of affection.

But, as there are no independent affections in the fabric of the mind, no paſſion that ſtands by itſelf, without ſome relation to the reſt, we cannot pronounce of any one, conſidered APART, that it is either *too ſtrong* or *too weak*. Its ſtrength and juſt proportion muſt be meaſured not only by its ſubſerviency to its own immediate end, but by the reſpect it bears to the whole ſyſtem of affection. Therefore, we ſay a paſſion is *too ſtrong*, not only when it defeats its own end, but when it impairs the force of other paſſions, which are equally neceſſary to form a *temper of mind* ſuited to a certain *œconomy* or *ſtate*; and too weak, not merely on account of its inſufficiency to anſwer its end, but becauſe it cannot ſuſtain its *part* or *office* in the balance of the whole ſyſtem. Thus the *love of life* may be *too ſtrong* when it takes from the *regard* due to one's country, and will not allow one bravely to encounter dangers, or even death on its account. Again, the *love of fame* may be *too weak* when it throws down the fences which render virtue more ſecure, or weakens the incentives which make it more active and public-ſpirited.

22 Limits of private affections.

If it be aſked, " How far may the affections to- " wards private good or happineſs be indulged?" One limit was before fixed for the particular indulgence of each, *viz*. their ſubordination to the common aggregate of good to the private ſyſtem. In theſe therefore a due regard is always ſuppoſed to be had to *health*, *reputation*, *fortune*, the *freedom of action*, the *unimpaired exerciſe of reaſon*, the *calm enjoyment of one's ſelf*, which are all private goods. Another limit now reſults from the balance of affection juſt named, *viz*. " The ſecurity and happineſs of others;" or, to expreſs it more generally, " a *private* affection may be ſafely indulged, when, by that indul- " gence, we do not violate the obligations which re- " ſult from our higher relations or public connections." A juſt reſpect therefore being had to theſe boundaries which nature has fixed in the breaſt of every man, what ſhould limit our purſuits of private happineſs?

Is

Is nature ſullen and penurious? Or does the God of nature envy the happineſs of his offspring?

[22] Colliſion of intereſts. Whether there is ever a real colliſion of intereſts between the *public* and *private* ſyſtem of affections, or the *ends* which each claſs has in view, will be afterwards conſidered; but where there is no colliſion, there is little or no danger of carrying either, but eſpecially the *public* affections, to exceſs, provided both kinds are kept ſubordinate to a diſcreet and cool *ſelf-love*, and to a calm and univerſal *benevolence*, which principles ſtand as guards at the head of each ſyſtem.

23 Reſult. This then is the conduct of the paſſions, conſidered as *particular* and *ſeparate* forces, carrying us out to their reſpective ends; and this is their balance or œconomy, conſidered as *compound* powers, or powers mutually related, acting in conjunction towards a *common* end, and conſequently as forming a *ſyſtem* or *whole*.

24 Subordination of powers. Now, whatever adjuſts or maintains this *balance*, whatever in the human conſtitution is formed for *directing* the paſſions ſo as to keep them from defeating their own end or interfering with each other, muſt be a principle of a *ſuperior* nature to them, and *ought* to direct their meaſures and govern their proportions. But it was found that *reaſon* or reflection is ſuch a principle, which points out the tendency of our paſſions, weighs their influence upon private and public happineſs, and ſhews the beſt means of attaining either. It having been likewiſe found that there is another directing or controling principle, which we call CONSCIENCE or the MORAL SENSE, which, by a native kind of authority, judges of affections and actions, pronouncing ſome *juſt* and *good*, and others *unjuſt* and *ill*; it follows that the paſſions, which are mere impulſe or blind forces, are principles inferior and ſubordinate to this *judging* faculty. *Therefore*, we would follow the order of nature, *i. e.* obſerve the mutual reſpects and the ſubordination which the different parts of the human conſtitution bear one to another, the paſſions ought to be ſubjected to the direction and authority of the *leading* or *controuling* principles.

25 In what it conſiſts. We conclude therefore, from this *induction*, that “the *conſtitution* or *juſt œconomy* of *human nature* conſiſts in a regular *ſubordination* of the *paſſions* and *affections* to the *authority* of *conſcience* and the *direction* of *reaſon*.”

26 Oeconomy of nature, or right temper. That *ſubordination* is *regular*, when the proportion formerly mentioned is maintained; that is to ſay, “When the *defenſive* paſſions are kept proportioned to our *dangers*; when the *private* paſſions are proportioned to our *wants*; and when the *public* affections are adapted to our *public connections*, and proportioned to the wants and dangers of others.”

27 Human virtue and perfection. But the *natural ſtate*, or the *ſound* and *vigorous conſtitution* of any creature, or the *juſt œconomy* of its powers, we call its *health* and *perfection*; and the acting agreeably to theſe, its *virtue* or *goodneſs*. Therefore, “the *health* and *perfectoin* of man muſt lie in the aforeſaid *ſupremacy* of *conſcience* and *reaſon*, and in the *ſubordination* of the paſſions to their *authority* and *direction*. And his *virtue* or *goodneſs* muſt conſiſt in acting agreeably to that *order* or *œconomy*.”

28 How conformable to reaſon. That ſuch an ornament of the mind, and ſuch a conduct of its powers and paſſions, will ſtand the teſt of *reaſon*, cannot admit of any diſpute. For, upon a fair examination into the conſequences of things, or the relations and aptitudes of *means* to *ends*, *reaſon* evidently demonſtrates, and *experience* confirms it, that, “To have our *defenſive paſſions* duly proportioned to our *dangers*, is the ſureſt way to avoid or get clear of them, and obtain the ſecurity we ſeek after.—To proportion our *private paſſions* to our *wants*, is the beſt means to ſupply them;—and, to adapt our *public affections* to our *ſocial relations*, and the *good* of others, is the moſt effectual method of fulfilling *one*, and procuring the *other*.” In this ſenſe, therefore, *virtue* may be ſaid to be a “*conduct* conformable to *reaſon*,” as reaſon diſcovers an apparent *aptitude*, in ſuch an *order* and *œconomy* of powers and paſſions, to anſwer the end for which they are *naturally* formed.

29 Connection between affections and ends, not the idea of moral obligation. If the idea of *moral obligation* is to be deduced merely from this *aptitude* or *connection* between certain paſſions, or a certain order and balance of paſſions, and certain ends obtained or to be obtained by them, then is *reaſon* or *reflection*, which perceives that aptitude or connection, the proper judge of *moral obligation*; and on this ſuppoſition it may be defined, as hath been done by ſome, the connection between the *affection* and the *end*, or, which is the ſame thing, between the *action* and the *motive*; for the *end* is the *motive* or the *final cauſe*, and the *affection* is the *action*, or its immediate natural cauſe. A man, from mere ſelf-love, may be induced to fulfil that obligation which is founded on the connection between the *defenſive* paſſions and their *ends*, or the *private* paſſions and their *ends*; becauſe in that caſe his own intereſt will prompt him to indulge them in the due proportion required. But if he has no affections which point beyond himſelf, no principle but *ſelf-love*, or ſome ſubtle modification of it, what ſhall intereſt him in the happineſs of others, where there is no connection between it and his own; or what ſenſe can he have of *moral obligation* to promote it? upon this ſcheme, therefore, without public or ſocial affection there could be no *motive*, and conſequently no moral obligation, to a beneficent diſintereſted conduct.

But if the mere connection between certain paſſions, or a certain order of paſſions and certain ends, are what conſtitutes or gives us the idea of *moral obligation*, then why may not the appoſiteneſs of any temper or conduct, nay, of any piece of machinery to obtain its end, form an equally ſtrict *moral obligation*? for the connection and aptitude are as ſtrong and invariable in the latter inſtances as in the former. But as this is confounding the moſt obvious differences of things, we muſt trace the idea of *moral obligation* to another and a more natural ſource.

30 Idea of it from experience. Let us appeal, therefore, to our inmoſt ſenſe and experience, “how we ſtand affected to thoſe different ſets of paſſions, in the juſt meaſure and balance of which we found a right temper to conſiſt.” For this is entirely a matter of experience, in which we muſt

muſt examine, as in any other natural inquiry, "what "are the genuine feelings and operations of nature, "and what affections or ſymptoms of them appear in "the given inſtance."

31 Why the defenſive paſſions approved.

The defenſive paſſions, as *anger* and *fear*, give us rather pain than pleaſure, yet we cannot help feeling them when provoked by injury, or expoſed to harm. We account the creature imperfect that wants them, becauſe they are neceſſary to his defence. Nay, we ſhould in ſome meaſure condemn ourſelves, did we want the neceſſary degree of *reſentment* and *caution*. But if our *reſentment* exceeds the wrong received, or our *caution* the evil dreaded, we then blame ourſelves for having over-acted our part. Therefore, while we are in danger to be totally deſtitute of them we reckon a *blameable defect*, and to feel them in a juſt, *i. e.* neceſſary meaſure, we *approve*, as ſuited to the nature and condition of ſuch a creature as man. But our ſecurity obtained, to continue to indulge them, we not only *diſapprove* as *hurtful*, but *condemn* as *unmanly*, *unbecoming*, and *mean-ſpirited*: Nor will ſuch a conduct afford any ſelf-approving joy when we coolly reflect upon it.

32 Why the private.

With regard to the *private* paſſions, ſuch as *love of life*, *pleaſure*, *eaſe*, and the like, as theſe aim at private good, and are neceſſary to the perfection and happineſs of the individual, we ſhould reckon any creature *defective*, and even *blameable*, that was deſtitute of them. Thus, we condemn the man who imprudently ruins his fortune, impairs his health, or expoſes his life; we not only pity him as an unfortunate creature, but feel a kind of *moral indignation* and contempt of him, for having made himſelf ſuch. On the other hand, though a diſcreet ſelf-regard does not attract our eſteem and veneration, yet we approve of it in ſome degree, in an higher and different degree from what we would regard a well-contrived machine, as neceſſary to conſtitute a finiſhed creature, nay, to complete the virtuous character, as exactly ſuited to our preſent indigent ſtate. There are ſome paſſions reſpecting private good, towards which we feel higher degrees of approbation, as the *love of knowledge*, of *action*, of *honour*, and the like. We eſteem them as marks of an ingenuous mind; and cannot help thinking the character in which they are wanting remarkably ſtupid, and in ſome degree *immoral*.

33 Why the public.

With regard to the ſocial affections, as *compaſſion*, *natural affection*, *friendſhip*, *benevolence*, and the like, we approve, admire, and love them in ourſelves, and, in all in whom we diſcover them, with an eſteem and approbation, if not different in kind, yet ſurely far ſuperior in degree, to what we feel towards the other paſſions. Theſe we reckon neceſſary, juſt, and excellently fitted to our ſtructure and ſtate; and the creature which wants them we call defective, ill-conſtituted, a kind of abortion. But the *public* affections we eſteem as ſelf-worthy, originally and eternally amiable.

34 Diſtinction between vehement and calm affections.

But among the *ſocial* affections we make an obvious and conſtant diſtinction, *viz.* between thoſe particular paſſions which urge us with a ſudden violence, and uneaſy kind of ſenſation, to purſue the good of their reſpective objects, as *pity*, *natural affection*, and the like; and thoſe calm diſpaſſionate affections and deſires which prompt us more ſteadily and uniformly to promote the happineſs of others. The former we generally call *paſſions*, to diſtinguiſh them from the other ſort, which go more commonly by the name of *affections*, or *calm deſires*. The firſt kind we approve indeed, and delight in; but we feel ſtill higher degrees of approbation and moral complacence towards the *laſt*, and towards all limitation of the particular inſtincts, by the principle of *univerſal benevolence*. The more objects the calm affections take in and the worthier theſe are, their dignity riſes in proportion, and with this our approbation keeps an exact pace. A character, on the other hand, which is quite diveſted of theſe public affections, which feels no love for the ſpecies, but inſtead of it entertains malice, rancour, and ill-will, we reckon totally immoral and unnatural.

Such then are the ſentiments and diſpoſitions we feel when theſe ſeveral orders of affection paſs before the mental eye.

35 Moral obligation.

Therefore, "that ſtate in which we feel ourſelves "moved, in the manner above deſcribed, towards "thoſe affections and paſſions, as they come under "the mind's review, and in which we are, inſtantaneouſly and independently of our choice or volition, "prompted to a *correſpondent* conduct, we call a "ſtate of *moral obligation*." Let us ſuppoſe, for inſtance, a parent, a friend, a benefactor, reduced to a condition of the utmoſt indigence and diſtreſs, and that it is in our power to give them immediate relief. To what conduct are we *obliged?* What *duty* does nature dictate and require in ſuch a caſe? Attend to nature, and nature will tell, will tell with a voice irreſiſtibly audible and commanding to the *human heart*, with an authority which no man can ſilence without being ſelf-condemned, and which no man can elude but at his peril: "That immediate relief *ought* to given." Again, let a friend, a neighbour, or even a ſtranger, have lodged a *depoſit* in our hands, and after ſome time reclaim it, no ſooner do theſe ideas of the confidence repoſed in us, and of property not *transferred*, but *depoſited*, occur, than we immediately and unavoidably feel and recognize the *obligation* to reſtore it. In both theſe caſes we ſhould condemn and even loathe ourſelves if we acted otherwiſe, as having done, or omitted doing, what we *ought* not, as having acted beneath the dignity of our nature;—contrary to our moſt intimate ſenſe of *right* and *wrong*:—we ſhould accuſe ourſelves as guilty of ingratitude, injuſtice, and inhumanity,—and be conſcious of deſerving the cenſure, and therefore dread the reſentment, of all rational beings.—But in complying with the *obligation*, we feel joy and ſelf-approbation,—are conſcious of an inviolable harmony between our nature and duty, and think ourſelves intitled to the applauſe of every impartial ſpectator of our conduct.

36 Moral obligation.

To *deſcribe* therefore what we cannot perhaps *define*, a ſtate of *moral obligation* is "that ſtate in "which a creature, endued with ſuch ſenſes, powers, "and affections of man, would condemn himſelf, and "think he deſerved the condemnation of all others, "ſhould he refuſe to fulfil it; but would approve him"ſelf, and expect the approbation of all others, upon "complying with it."

And

37 Moral agent. And we call him a MORAL AGENT, who is in ſuch a *ſtate*, or is ſubject to *moral obligation*. Therefore, as man's *ſtructure* and *connections* often ſubject him to ſuch a ſtate of *moral obligation*, we conclude that *he* is a *moral agent*. But as man may ſometimes act without *knowing* what he does, as in caſes of *frenſy* or *diſeaſe*, or in many *natural functions*; or, knowing what he does, he may act without *choice* or *affection*, as in caſes of *neceſſity* or *compulſion*; therefore to

38 Moral action good and bad. denominate an action *moral*, i. e. *approveable*, or *blameable*, it muſt be done *knowingly* and *willingly*, or *from affection* and *choice*. "A *morally good action* then is to fulfil a *moral obligation* knowingly "and willingly." And a *morally bad action*, or an *immoral action*, is, "to violate a *moral obligation* "knowingly and willingly."

39 Moral character and temper good and bad. As not an *action*, but a *ſeries of actions*, conſtitute a *character*; as not an *affection*, but a *ſeries of affections*, conſtitute a *temper*; and as we denominate things by the groſs, *à fortiori*, or by the qualities which chiefly prevail in them; therefore we call that a "*morally good character*, in which a *ſeries of morally good actions* prevail;" and that a "*morally good temper*, in which a *ſeries of morally good affections* have the aſcendant." A bad character and bad temper are the reverſe. But where the above mentioned *order* or *proportion* of paſſions is maintained, there a *ſeries* of *morally* good *affections and actions* will prevail. *Therefore*, "to maintain that order "and proportion, is to have a *morally good temper* "*and character*." But a "morally good temper and "character is *moral rectitude*, *integrity*, *virtue*, or "the *completion of duty*."

40 How we come by the idea of moral obligation. If it be aſked, after all, "how we come by the idea "of *moral obligation* or *duty*?" We may anſwer, that we come by it in the ſame way as by our other *original* and *primary* perceptions. We receive them all from nature, or the great Author of nature. For this idea of *moral obligation* is not a creature of the mind, or dependent on any previous act of volition, but ariſes on certain occaſions, or when certain other ideas are preſented to the mind, as neceſſarily, inſtantaneouſly, and unavoidably, as *pain* does upon too near an approach to the fire, or *pleaſure* from the fruition of any good. It does not, for inſtance, depend on our choice, whether we ſhall feel the *obligation* to ſuccour a diſtreſſed parent, or to reſtore a depoſit intruſted to us when it is recalled. We cannot call this a *compound idea* made up of one or more ſimple ideas. We may indeed, nay we muſt, have ſome ideas antecedent to it, *e. g.* that of a parent—in diſtreſs—of a child—able to relieve—of the relation of one to the other—of a truſt—of right, &c. But none of theſe ideas conſtitute the perception of *obligation*. This is an idea quite diſtinct from, and ſomething ſuperadded to, the ideas of the correlatives, or the relation ſubſiſting between them. Theſe indeed, by a law of our nature, are the occaſion of ſuggeſting it; but they are as totally different from it as colours are from ſounds. By ſenſe of reflection we perceive the correlatives, our memory recals the favours or depoſit we received, the various circumſtances of the caſe are matters of fact or experience; but ſome delicate inward *organ* or *power*, or call it what we pleaſe, does, by a certain inſtantaneous ſympathy, antecedent to the cool deductions of reaſon, and independent of previous inſtruction, art, or volition, *perceive the moral harmony*, the *living*, *irreſiſtible charms of moral obligation*, which immediately intereſts the correſpondent paſſions, and prompts us to fulfil its awful dictates.

We need not apprehend any danger from the quickneſs of its deciſions, nor be frightened becauſe it looks like *inſtinct*, and has been called ſo. Would we approve one for deliberating long, or reaſoning the matter much at leiſure, whether he ſhould relieve a diſtreſſed parent, feed a ſtarving neighbour, or reſtore the truſt committed to him? ſhould we not ſuſpect the reaſoner of knavery, or of very weak affections to virtue? we employ *reaſon*, and worthily employ it, in examining the condition, relations, and other circumſtances of the agent or patient, or of thoſe with whom either of them are connected, or, in other words, the *ſtate of the caſe*: and in complicated caſes, where the circumſtances are many, it may require no ſmall attention to find the true ſtate of the caſe; but when the relations of the agent or patient, and the circumſtances of the action are obvious, or come out ſuch after a fair trial, we ſhould ſcarce approve him who demurs on the obligation to that conduct which the caſe ſuggeſts. 41 The uſe of reaſon in moral caſes.

From what has been ſaid it is evident, that it is not the pleaſure or agreeable ſenſations which accompany the exerciſe of the ſeveral affections, nor thoſe conſequent to the actions, that conſtitute *moral obligation*, or excite in us the idea of it. That pleaſure is poſterior to the idea of obligation, and frequently we are obliged, and acknowledge ourſelves under an obligation, to ſuch affections and actions as are attended with pain; as in the trials of virtue, where we are obliged to ſacrifice private to public good, or a preſent pleaſure to a future intereſt. We have pleaſure in ſerving an aged parent, but it is neither the perception nor proſpect of that pleaſure which gives us the idea of obligation to that conduct. 42 [52] Pleaſure, not the idea of obligation.

CHAP. III.

The FINAL *Cauſes of our moral Faculties of* PERCEPTION *and* AFFECTION.

WE have now taken a *general* proſpect of MAN and of his *moral powers* and *connections*, and on theſe erected a ſcheme of *duty*, or *moral obligation*, which ſeems to be confirmed by *experience*, conſonant to *reaſon*, and approved by his moſt inward and moſt ſacred *ſenſes*. It may be proper in the next place to take a more particular view of the *final cauſes* of thoſe delicate *ſprings* by which he is *impelled* to action, and of thoſe *clogs* by which he is reſtrained from it. By this detail we ſhall be able to judge of their aptitude to anſwer their end, in a creature endued with his *capacities*, ſubject to his *wants*, expoſed to his *dangers*, and ſuſceptible of his *enjoyments*; and from thence we ſhall be in a condition to pronounce concerning the *end* of his *whole ſtructure*, its *harmony* with its *ſtate*, and conſequently its ſubſerviency to anſwer the great and benevolent intentions of its author. 53 The ſurvey propoſed.

The ſupreme Being has ſeen fit to blend in the whole of things a prodigious variety of diſcordant and contrary

[53] *Inward anatomy of the ſyſtem of the mind.* contrary principles, *light* and *darkneſs*, *pleaſure* and *pain*, *good* and *evil*. There are multifarious natures, *higher* and *lower*, and many intermediate ones between the wide-diſtant extremes. Theſe are differently ſituated, variouſly adjuſted, and ſubjected to each other, and all of them ſubordinate to the order and perfection of the whole. We may ſuppoſe *man* placed as in a centre amidſt thoſe innumerable orders of beings, by his *outward* frame drawing to the *material* ſyſtem, and by his *inward* connected with the INTELLECTUAL or *moral*, and of courſe affected by the laws which govern both, or affected by that good and that ill which reſult from thoſe laws. In this infinite variety of *relations* with which he is ſurrounded, and of *contingencies* to which he is liable, he feels ſtrong attractions to the *good*, and violent repulſions or averſions to the *ill*. But as good and ill are often blended, and wonderfully complicated one with the other; as they ſometimes immediately produce and run up into each other, and at other times lie at great diſtances, yet by means of intervening links introduce one another; and as theſe effects are often brought about in conſequence of hidden relations and general laws, of the energy of which he is an incompetent judge, it is eaſy for him to miſtake *good* for *evil*, and *evil* for *good*, and conſequently he may be frequently attracted by ſuch things as are deſtructive, or repel ſuch as are ſalutary. Thus, by the tender and complicated frame of his body, he is ſubjected to a great variety of ills, to *ſickneſs*, *cold*, *heat*, *fatigue*, and innumerable *wants*. Yet his knowledge is ſo narrow withal, and his reaſon ſo weak, that in many caſes he cannot judge, in the way of inveſtigation or reaſoning, of the connections of thoſe effects with their reſpective cauſes, or of the various latent energies of natural things. He is therefore informed of this connection by the experience of certain *ſenſes* or *organs* of *perception*, which, by a mechanical inſtantaneous motion, feel the *good* and the *ill*; receiving pleaſure from *one*, and pain from the *other*. By theſe, without any reaſoning, he is taught to attract or chuſe what tends to his welfare, and to repel and avoid what tends to his ruin. Thus, by his ſenſes of *taſte* and *ſmell*, or by the *pleaſure* he receives from certain kinds of food, he is admoniſhed which agree with his conſtitution, and by an oppoſite ſenſe of *pain* he is informed which ſorts diſagree, or are deſtructive of it; but is not by means of this inſtructed in the inward natures and conſtitutions of things.

54 *Uſe of appetites and paſſions.* Some of thoſe ſenſes are armed with ſtrong degrees of *uneaſineſs* or *pain*, in order to urge him to ſeek after ſuch objects as are ſuited to them. And theſe reſpect his more immediate and preſſing *wants*; as the ſenſe of *hunger*, *thirſt*, *cold*, and the like; which, by their painful importunities, compel him to provide *food*, *drink*, *raiment*, *ſhelter*. Thoſe inſtincts by which we are thus prompted with ſome kind of commotion or violence to attract and purſue *good*, or to repel and avoid *ill*, we call *appetites* and *paſſions*. By our ſenſes then we are informed of what is *good* or *ill* to the *private ſyſtem*, or the *individual*; and by our *private appetites* and *paſſions* we are impelled to one, and reſtrained from the other.

In conſequence of this machinery, and the great train of wants to which our nature ſubjects us, we are engaged in a continued ſeries of occupations, which often require much application of thought, or great bodily labour, or both. The neceſſaries of life, food, cloaths, ſhelter, and the like, muſt be provided; conveniencies muſt be acquired to render life ſtill more eaſy and comfortable. In order to obtain theſe, arts, induſtry, manufactures, and trade, are neceſſary. And to ſecure to us the peaceable enjoyment of their fruits, civil government, policy, and laws, muſt be contrived, and the various buſineſs of public life carried on: thus while man is concerned and buſied in making proviſion, or obtaining ſecurity for himſelf, he is by degrees engaged in connections with a family, friends, neighbours, a community, or a commonwealth. Hence ariſe new wants, new intereſts, new cares, and new employments. The paſſions of one man interfere with thoſe of another. Intereſts are oppoſed. Competitions ariſe, contrary courſes are taken. Diſappointments happen, diſtinctions are made, and parties formed. This opens a vaſt ſcene of diſtraction and embarraſſment, and introduces a mighty train of good and ill, both public and private. Yet amidſt all this confuſion and hurry, plans of action muſt be laid, conſequences foreſeen or guarded againſt, inconveniencies provided for; and frequently particular reſolutions muſt be taken, and ſchemes executed, without reaſoning or delay. 55 *Man's outward ſtate.*

56 *Proviſions for it.* Now what proviſion has the Author of our nature made for this neceſſitous condition? How has he fitted the actor, man, for playing his part in this perplexed and buſy ſcene?

57 *By public ſenſes and paſſions.* Our ſupreme Parent, watchful for the whole, has not left himſelf without a witneſs here neither, and hath made nothing imperfect, but all things are double one againſt another. He has not left man to be informed, only by the cool notices of reaſon, of the *good* or *ill*, the *happineſs* or *miſery* of his fellow-creatures. He has made him ſenſible of their good and happineſs, but eſpecially of their ill and miſery, by an immediate ſympathy, or quick *feeling* of *pleaſure* and of *pain*.

58 *Pity.* The latter we call PITY or COMPASSION. For the former, though every one, who is not quite diveſted of humanity, feels it in ſome degree, we have not got a name, unleſs we call it CONGRATULATION or *joyful* SYMPATHY, or that *good humour* which ariſes on ſeeing others pleaſed or happy. 59 *Congratulation.* Both theſe feelings have been called in general the PUBLIC or COMMON SENSE, κοινη μνημοσυνη, by which we feel for others, and are intereſted in their concerns as really, though perhaps leſs ſenſibly than in our own.

60 *Reſentment.* When we ſee our fellow-creatures unhappy through the fault or injury of others, we feel *reſentment* or *indignation* againſt the *unjuſt* cauſers of that miſery. If we are conſcious that it has happened through our fault or *injurious* conduct, we feel *ſhame*; and both theſe claſſes of *ſenſes* and *paſſions*, regarding *miſery* and *wrong*, are armed with ſuch ſharp ſenſations of *pain* as not only prove a powerful guard and ſecurity to the *ſpecies*, or *public ſyſtem*, againſt thoſe ills it may, but ſerve alſo to leſſen or remove thoſe ills it does, ſuffer. Compaſſion draws us out of ourſelves to bear a part of the misfortunes of others, powerfully ſolicits us in their favour, melts us at ſight of their diſtreſs,

ſtreſs, and makes us in ſome degree unhappy till they are relieved from it. It is peculiarly well adapted to the condition of human life, becauſe it is much more and oftener in our power to do miſchief than good, and to prevent or leſſen miſery than to communicate poſitive happineſs; and therefore it is an admirable reſtraint upon the more *ſelfiſh* paſſions, or thoſe violent impulſes that carry us to the hurt of others.

61 Public affections.

There are other particular *inſtincts* or *paſſions* which intereſt us in the concerns of others, even while we are moſt buſy about our own, and which are ſtrongly attractive of *good*, and repulſive of *ill* to them. Such are *natural affection, friendſhip, love, gratitude, deſire of fame, love of ſociety*, of *one's country*, and others that might be named. Now as the *private* appetites and paſſions were found to be armed with ſtrong ſenſations of deſire and uneaſineſs, to prompt man the more effectually to ſuſtain labours, and to encounter dangers in purſuit of thoſe goods that are neceſſary to the preſervation and welfare of the individual, and to avoid thoſe ills which tend to his deſtruction; in like manner it was neceſſary, that this *other* claſs of deſires and affections ſhould be prompted with as quick ſenſations of pain, not only to counteract the ſtrength of their antagoniſts, but to engage us in a virtuous activity for our relations, families, friends, neighbours, country. Indeed our *ſenſe* of *right* and *wrong* will admoniſh us that it is our *duty*, and *reaſon* and *experience* farther aſſure us that it is both our *intereſt* and beſt *ſecurity*, to promote the happineſs of others; but that *ſenſe*, that *reaſon*, and that *experience*, would frequently prove but weak and ineffectual prompters to ſuch a conduct, eſpecially in caſes of danger and hardſhip; and amidſt all the importunities of nature, and that conſtant hurry in which the *private* paſſions involve us, without the aid of thoſe particular *kind* affections which mark out to us particular ſpheres of duty, and with an agreeable violence engage and fix us down to them.

62 Contraſt or balance of paſſions.

It is evident, therefore, that thoſe two claſſes of affection, the *private* and *public*, are ſet one againſt the other, and deſigned to control and limit each other's influence, and thereby to produce a juſt balance in the whole *. In general, the violent ſenſations of pain and uneaſineſs which accompany hunger, thirſt, and the other private appetites, or too great fatigue of mind as well as of body, prevent the individual from running to great exceſſes in the exerciſe of the higher functions of the mind, as too intenſe thought in the ſearch of truth, violent application to buſineſs of any kind, and different degrees of romantic heroiſm. On the other hand, the finer ſenſes of *perception*, and thoſe *generous deſires* and *affections* which are connected with them, the *love of action*, of *imitation*, of *truth, honour, public virtue*, and the like, are wiſely placed in the oppoſite ſcale, in order to prevent us from ſinking into the dregs of the *animal* life, and debaſing the dignity of man below the condition of brutes. So that, by the mutual re-action of thoſe oppoſite powers, the bad effects are prevented that would naturally reſult from their acting ſingly and apart, and the good effects are produced which each are ſeverally formed to produce.

* Vid. *Hutcheſon's Conduct of the Paſſions, treat.* 1. § 2.

The ſame wholeſome oppoſition appears likewiſe in the particular counter-workings of the *private* and *public* affections one againſt the other. Thus *compaſſion* is adapted to counterpoiſe the *love of eaſe*, of *pleaſure*, and of *life*, and to diſarm or to ſet bounds to *reſentment*; and *reſentment* of injury done to ourſelves, or to our friends who are dearer than ourſelves, prevents an effeminate *compaſſion* or *conſternation*, and gives us a noble contempt of labour, pain, and death. *Natural affection, friendſhip, love of one's country*, nay, *zeal* for any particular virtue, are frequently more than a match for the whole train of *ſelfiſh* paſſions. On the other hand, without that intimate over-ruling paſſion of *ſelf-love*, and thoſe private deſires which are connected with it, the *ſocial* and *tender inſtincts* of the human heart would degenerate into the wildeſt dotage, the moſt torturing anxiety, and downright frenſy.

63 Contraſt or balance of public and private paſſions.

64 Contraſts among thoſe of the ſame claſſes.

But not only are the different orders or claſſes of affection checks one upon another, but paſſions of the ſame claſſes are mutual clogs. Thus, how many are with-held from the violent outrages of *reſentment* by *fear*? And how eaſily is *fear* controlled in its turn, while mighty wrongs awaken a mighty *reſentment*! The *private* paſſions often interfere, and therefore moderate the violence of each other; and a calm *ſelf-love* is placed at their head, to direct, influence, and control their particular attractions and repulſions. The *public* affections likewiſe reſtrain one the other; and all of them are put under the control of a calm diſpaſſionate *benevolence*, which ought in like manner to direct and limit their particular motions. Thus moſt part, if not all the paſſions, have a twofold aſpect, and ſerve a twofold end. In *one* view they may be conſidered as *powers*, impelling mankind to a certain courſe, with a *force* proportioned to the *apprehended moment* of the good they aim at. In *another* view they appear as *weights*, balancing the action of the *powers*, and controlling the violence of their impulſes. By means of theſe *powers* and *weights* a natural *poiſe* is ſettled in the human breaſt by its all-wiſe Author, by which the creature is kept tolerably ſteady and regular in his courſe, amidſt that variety of ſtages through which he muſt paſs.

65 Particular perceptions or inſtincts of approbation.

But this is not all the proviſion which God has made for the hurry and perplexity of the ſcene in which man is deſtined to act. Amidſt thoſe infinite attractions and repulſions towards private and public good and ill, mankind either cannot often foreſee the *conſequences* or *tendencies* of all their actions towards one or other of theſe, eſpecially where thoſe tendencies are intricate and point different ways, or thoſe conſequences remote and complicated; or though, by careful and cool inquiry, and a due improvement of their rational powers, they might find them out, yet, diſtracted as they are with buſineſs, amuſed with trifles, diſſipated by pleaſure, and diſturbed by paſſion, they either have or can find no leiſure to attend to thoſe conſequences, or to examine how far this or that conduct is productive of private or public good on the whole. Therefore, were it left entirely to the ſlow and ſober deductions of reaſon to trace thoſe tendencies, and make out thoſe conſequences, it is evident, that in many particular inſtances the buſineſs of life muſt ſtand ſtill, and many important occaſions of ac-

tion be loſt, or perhaps the groſſeſt blunders be committed. On this account the Deity, beſides that general approbation which we beſtow on every degree of *kind* affection, has moreover implanted in man many particular *perceptions* or *determinations* to approve of certain *qualities* or *actions*, which, in effect, tend to the advantage of ſociety, and are connected with private good, though he does not always ſee that tendency, nor mind that connection. And theſe *perceptions* or *determinations* do without reaſoning point out, and, antecedent to views of intereſt, prompt to a conduct beneficial to the *public*, and uſeful to the *private* ſyſtem. Such is that *ſenſe of candour and veracity*, that *abhorrence of fraud and falſehood*, that *ſenſe of fidelity, juſtice, gratitude, greatneſs of mind, fortitude, clemency, decorum*; and that *diſapprobation of knavery, injuſtice, ingratitude, meanneſs of ſpirit, cowardice, cruelty*, and *indecorum*, which are natural to the human mind. The *former* of thoſe diſpoſitions, and the actions flowing from them, are approved, and thoſe of the latter kind diſapproved by us, even abſtracted from the view of their tendency or conduciveneſs to the happineſs or miſery of others, or of ourſelves. In one we diſcern a *beauty*, a *ſuperior excellency*, a congruity to the *dignity* of man; in the other a *deformity*, a *littleneſs*, a *debaſement*, of human nature.

66 Others of an inferior order.

There are other principles alſo connected with the good of ſociety, or the happineſs and perfection of the individual, though that connection is not immediately apparent which we behold with real complacency and approbation, though perhaps inferior in degree, if not in kind, ſuch as *gravity, modeſty, ſimplicity of deportment, temperance, prudent œconomy*; and we feel ſome degree of contempt and diſlike where they are wanting, or where the oppoſite qualities prevail. Theſe and the like *perceptions* or *feelings* are either different *modifications* of the *moral ſenſe*, or *ſubordinate* to it, and plainly ſerve the ſame important purpoſe, being expeditious *monitors* in the ſeveral emergencies of a various and diſtracted life, of what is *right*, what is *wrong*, what is to be *purſued*, and what *avoided*; and, by the pleaſant or painful conſciouſneſs which attends them, exerting their influence as powerful *prompters* to a ſuitable conduct.

67 Their general tendencies.

From a ſlight inſpection of the above-named principles, it is evident they all carry a friendly aſpect to *ſociety* and the *individual*, and have a more immediate or a more remote tendency to promote the *perfection* or *good* of both. This tendency cannot be always foreſeen, and would be often miſtaken or ſeldom attended to by a weak, buſy, ſhort-ſighted creature like man, both raſh and variable in his opinions, a dupe to his own paſſions, or to the deſigns of others, liable to ſickneſs, to want, and to error. Principles, therefore, which are ſo nearly linked with *private ſecurity* and *public good*, by directing him, without operoſe reaſoning, where to find *one* and how to promote the *other*; and, by prompting him to a conduct conducive to both, are admirably adapted to the exigencies of his preſent ſtate, and wiſely calculated to obtain the ends of univerſal benevolence.

It were eaſy, by conſidering the ſubject in another light, to ſhew, in a curious detail of particulars, how wonderfully the inſide of man, or that aſtoniſhing train of *moral powers* and *affections* with which he is endued, is fitted to the ſeveral ſtages of that *progreſſive* and *probationary* ſtate through which he is deſtined to paſs. As our faculties are narrow and limited, and riſe from very ſmall and imperfect beginnings, they muſt be improved by exerciſe, by attention, and repeated trials. And this holds true not only of our *intellectual*, but of our *moral* and *active* powers. The former are liable to errors in ſpeculation, the latter to blunders in practice, and both often terminate in miſfortunes and pains. And thoſe errors and blunders are generally owing to our paſſions, or to our too forward and warm *admiration* of thoſe partial *goods* they naturally purſue, or to our fear of thoſe partial *ills* they naturally repel. Thoſe misfortunes, therefore, lead us back to conſider where our miſconduct lay, and whence our errors flowed; and conſequently are ſalutary pieces of trial, which tend to enlarge our views, to *correct* and *refine* our paſſions, and conſequently improve both our *intellectual* and *moral* powers. Our paſſions then are the rude materials of our virtue, which Heaven has given us to work up, to refine and poliſh into an harmonious and divine piece of workmanſhip. They furniſh out the whole machinery, the calms and ſtorms, the lights and ſhades of human life. They ſhew mankind in every attitude and variety of character, and give *virtue* both its ſtruggles and its triumphs. To conduct them well in every ſtate, is merit; to abuſe or miſapply them, is demerit.

68 Paſſions fitted to a ſtate of trial.

69 To a progreſſive ſtate.

The different ſets of *ſenſes, powers*, and *paſſions*, which unfold themſelves in thoſe ſucceſſive ſtages, are both neceſſary and adapted to that *riſing* and *progreſſive* ſtate. Enlarging views and growing connections require new paſſions and new habits; and thus the mind, by theſe continually expanding and finding a progreſſive exerciſe, riſes to higher improvements, and puſhes forward to maturity and perfection.

70, [71] Harmony of our ſtructure and ſtate.

In this beautiful œconomy and harmony of our ſtructure, both outward and inward, with that ſtate we may at once diſcern the great lines of our duty traced out in the faireſt and brighteſt characters, and contemplate with admiration a more auguſt and marvellous ſcene of divine wiſdom and goodneſs laid in the human breaſt, than we ſhall perhaps find in the whole compaſs of nature.

72 In what œconomy virtue conſiſts.

From this detail it appears, that man, by his original frame, is made for a *temperate, compaſſionate, benevolent, active*, and *progreſſive* ſtate. He is ſtrongly *attractive* of the *good*, and *repulſive* of the *ills*, which befal others as well as himſelf. He feels the higheſt *approbation* and *moral complacence* in thoſe affections, and in thoſe actions, which immediately and directly reſpect the *good* of others, and the higheſt *diſapprobation* and *abhorrence* of the contrary. Beſides theſe, he has many particular *perceptions* or *inſtincts* of *approbation*, which, though perhaps not of the ſame kind with the others, yet are accompanied with correſpondent degrees of affection, proportioned to their reſpective tendencies to the *public good*. *Therefore*, by acting agreeably to theſe principles, *man* acts agreeably to his ſtructure, and fulfils the benevolent

nevolent intentions of its author. But we call a thing *good* when it anſwers its *end*, and a creature *good* when he acts in a *conformity* to his *conſtitution*. Conſequently, *man* muſt be denominated *good* or *virtuous* when he acts ſuitably to the *principles* and *deſtination* of his nature.

PART II.

CHAP. I.

The principal Diſtinctions of DUTY *or* VIRTUE.

WE have now conſidered the *conſtitution* and *connections* of *man*, and on thoſe erected a general ſyſtem of *duty* or *moral obligation*, conſonant to *reaſon*, approved by his moſt ſacred and intimate *ſenſe*, ſuitable to his *mixed condition*, and confirmed by the *experience* of mankind. We have alſo traced the *final cauſes* of his *moral faculties* and *affections* to thoſe noble purpoſes they anſwer, with regard both to the *private* and the *public ſyſtem*.

73 General diviſion of duty.

From this induction it is evident, that there is one order or claſs of duties which *man* owes to *himſelf*: another to *ſociety*: and a third to *God*.

74 Duty to one's ſelf.

The duties he owes to *himſelf* are founded chiefly on the *defenſive* and *private* paſſions, which prompt him to purſue whatever tends to *private good* or *happineſs*, and to avoid or ward off whatever tends to *private ill* or *miſery*. Among the various goods which allure and ſolicit him, and the various ills which attack or threaten him, "To be intelligent and accurate in "ſelecting *one*, and rejecting the *other*, or in pre"ferring the moſt *excellent goods*, and avoiding the "moſt *terrible ills*, when there is a competition among "either, and to be diſcreet in uſing the beſt means "to attend the *goods* and avoid the *ills*, is what we "call *prudence*." This, in our *inward* frame, correſponds to *ſagacity*, or *quickneſs of ſenſe* in our *outward*.—"To proportion our *defenſive paſſions* to our "*dangers*, we call *fortitude*;" which always implies "a juſt mixture of calm reſentment or animoſity, and "well-governed caution." And this *firmneſs of mind* anſwers to the *ſtrength* and *muſcling* of the *body*.—And "duly to adjuſt our *private paſſions* to our wants, "or to the reſpective moment of the good we affect "or purſue, we call *temperance*;" which does therefore always imply, in this large ſenſe of the word, "a "juſt balance or command of the paſſions."

75 Duties to ſociety.

The *ſecond claſs* of *duties* ariſes from the *public* or *ſocial affections*, "the juſt harmony or proportion of "which to the *dangers* and *wants* of others, and to "the ſeveral *relations* we bear, commonly goes by "the name of *juſtice*." This includes the whole of our duty to *ſociety*, to its *parent*, and the *general polity* of *nature*; particularly *gratitude*, *friendſhip*, *ſincerity*, *natural affection*, *benevolence*, and the other *ſocial virtues*: This, being the *nobleſt temper*, and *faireſt complection* of the ſoul, correſponds to the *beauty* and *fine proportion* of the perſon. The virtues comprehended under the former claſs, eſpecially *prudence* and *fortitude*, may likewiſe be transferred to this; and according to the various circumſtances in which they are placed, and the more confined or more extenſive ſphere in which they operate, may be denominated *private*, *œconomical*, or *civil prudence*, *fortitude*, &c. Theſe direct our conduct with regard to the *wants* and *dangers* of thoſe leſſer or greater circles with which they are connected.

76 Duties to God.

The *third* claſs of duties reſpects the DEITY, and ariſes from the *public affections*, and the ſeveral glorious *relations* which he ſuſtains to us, as our *creator*, *benefactor*, *lawgiver*, *judge*, &c.

77 Method.

We choſe to conſider this *ſet* of duties in the laſt place, becauſe, though *prior* in dignity and excellency, they ſeem to be *laſt* in order of time, as thinking it the moſt ſimple and eaſy method to follow the gradual progreſs of nature, as it takes its riſe from individuals, and ſpreads through the *ſocial* ſyſtem, and ſtill aſcends upwards, till at length it ſtretches to its almighty Parent and Head, and ſo terminates in thoſe duties which are *higheſt* and *beſt*.

78 Piety.

The duties reſulting from theſe *relations* are, *reverence*, *gratitude*, *love*, *reſignation*, *dependence*, *obedience*, *worſhip*, *praiſe*; which, according to the model of our finite capacities, muſt maintain ſome ſort of proportion to the grandeur and perfection of the object whom we venerate, love, and obey. "This "*proportion* or *harmony* is expreſſed by the general "name of *piety* or *devotion*," which is always ſtronger or weaker according to the greater or leſs apprehended excellency of its object. This ſublime principle of virtue is the enlivening ſoul which animates the *moral ſyſtem*, and that cement which binds and ſuſtains the other duties which *man* owes to *himſelf* or to *ſociety*.

79 [84] Conſcience, and its diviſions.

This then is the general temper and conſtitution of virtue, and theſe are the principal lines or diviſions of duty. To thoſe good diſpoſitions which reſpect the ſeveral objects of our duty, and to all actions which flow from ſuch diſpoſitions, the mind gives its ſanction or teſtimony. And this ſanction or judgment concerning the moral quality, or the goodneſs of actions or diſpoſitions, moraliſts call *conſcience*. When it judges of an action that is to be performed, it is called an *antecedent conſcience*; and when it paſſes ſentence on an action which is performed, it is called a *ſubſequent conſcience*. The tendency of an action to produce happineſs, or its external conformity to a law, is termed its *material* goodneſs. But the good diſpoſitions from which an action proceeds, or its conformity to law in every reſpect, conſtitutes its *formal* goodneſs.

85 Diviſions of conſcience.

When the mind is ignorant or uncertain about the moment of an action, or its tendency to private or public good, or when there are ſeveral circumſtances in the caſe, ſome of which, being doubtful, render the mind dubious concerning the morality of the action, this is called a *doubtful* or *ſcrupulous conſcience*; if it miſtakes concerning theſe, it is called an *erroneous conſcience*. If the *error* or *ignorance* is *involuntary* or *invincible*, the action proceeding from that *error*, or from that *ignorance*, is reckoned *innocent*, or not imputable. If the error or ignorance is *ſupine* or *affected*, *i. e.* the effect of negligence, or of affectation and

and wilful inadvertence, the conduct flowing from ſuch error, or ſuch ignorance, is *criminal* and *imputable.* Not to follow one's conſcience, though erroneous and ill-informed, is *criminal*, as it is the guide of life; and to counteract it, ſhews a depraved and incorrigible ſpirit. Yet to follow an erroneous conſcience is likewiſe criminal, if that error which miſled the conſcience was the effect of inattention, or of any criminal paſſion *.

* *Hutcheſ. Mor. Inſt.* lib. 2. c. 3.

86 How conſcience is to be rectified.

If it be aſked, "How an erroneous conſcience ſhall "be rectified, ſince it is ſuppoſed to be the only guide "of life, and judge of morals?" We anſwer, in the very ſame way that we would rectify reaſon if at any time it ſhould judge wrong, as it often does, *viz.* by giving it proper and ſufficient materials for judging right, *i. e.* by inquiring into the whole ſtate of the caſe, the relations, connections, and ſeveral obligations of the actor, the conſequences and other circumſtances of the action, or the ſurpluſage of private or public good which reſults, or is likely to reſult, from the action or from the omiſſion of it. If thoſe circumſtances are fairly and fully ſtated, the conſcience will be juſt and impartial in its deciſion: for, by a neceſſary law of our nature, it approves and is well affected to the *moral form*; and if it ſeems to approve of *vice* or *immorality*, it is always under the notion or maſk of ſome *virtue*. So that, ſtrictly ſpeaking, it is not conſcience which errs; for its ſentence is always conformable to the view of the caſe which lies before it; and is *juſt*, upon the ſuppoſition that the caſe is truly ſuch as it is repreſented to it. All the fault is to be imputed to the agent, who neglects to be better informed, or who, through weakneſs or wickedneſs, haſtens to paſs ſentence from an imperfect evidence.

CHAP. II.

Of Man's Duty to HIMSELF. *Of the Nature of* GOOD, *and the Chief* GOOD.

87 Diviſions of good.

EVERY creature, by the conſtitution of his nature, is determined to love himſelf; to purſue whatever tends to his preſervation and happineſs, and to avoid whatever tends to his hurt and miſery. Being endued with ſenſe and perception, he muſt neceſſarily receive *pleaſure* from ſome objects, and *pain* from others. Thoſe objects which give pleaſure, are called *good*; and thoſe which give pain, *evil.* To the former he feels that attraction or motion we call *deſire*, or *love*: To the latter, that impulſe we call *averſion*, or *hatred.* To objects which ſuggeſt neither pleaſure nor pain, and are apprehended of no uſe to procure one or ward off the other, we feel neither *deſire* nor *averſion*; and ſuch objects are called *indifferent*. Thoſe objects which do not of themſelves produce pleaſure or pain, but are the *means* of procuring either, we call *uſeful* or *noxious*. Towards them we are affected in a ſubordinate manner, or with an *indirect* and *reflective* rather than a *direct* and *immediate* affection. All the original and particular affections of our nature lead us out to and ultimately reſt in the firſt kind of objects, *viz.* thoſe which give immediate pleaſure, and which we therefore call *good, directly ſo*. The calm affection of *ſelf-love* alone is converſant about ſuch objects as are only *conſequentially good*, or merely uſeful to ourſelves.

88 Moral good.

But, beſides thoſe ſorts of objects which we call *good*, merely and ſolely as they give pleaſure, or are means of procuring it, there is an higher and nobler ſpecies of good, towards which we feel that peculiar movement we call *approbation* or *moral complacency*; and which we *therefore* denominate *moral good.* Such are our affections, and the conſequent actions to them. The perception of this is, as has been already obſerved, quite diſtinct in kind from the perception of other ſpecies; and though it may be connected with *pleaſure* or *advantage* by the benevolent conſtitution of nature, yet it conſtitutes a *good* independent of that pleaſure and that advantage, and far ſuperior not in degree only but in dignity to both. The *other*, *viz.* the *natural good*, conſiſts in obtaining thoſe pleaſures which are adapted to the peculiar ſenſes and paſſions ſuſceptible of them, and is as various as are thoſe ſenſes and paſſions. This, *viz.* the *moral* good, lies in the right conduct of the ſeveral ſenſes and paſſions, or their juſt proportion and accommodation to their reſpective objects and relations; and this is of a more ſimple and invariable kind.

89 Human happineſs.

By our ſeveral ſenſes we are capable of a great variety of pleaſing ſenſations. Theſe conſtitute diſtinct ends, or objects ultimately purſuable for their own ſake. To theſe ends, or ultimate objects, correſpond peculiar appetites or affections, which prompt the mind to purſue them. When theſe ends are attained, there it reſts, and looks no farther. Whatever therefore is purſuable, not on its own account, but as ſubſervient or neceſſary to the attainment of ſomething elſe that is intrinſically valuable for its own ſake, be that value ever ſo great, or ever ſo ſmall, we call a *mean*, and not an *end*. So that *ends* and *means* conſtitute the *materials*, or the very *eſſence* of our *happineſs*. Conſequently happineſs, *i. e. human* happineſs, cannot be one ſimple uniform thing in creatures conſtituted, as we are, with ſuch various ſenſes of pleaſure, or ſuch different capacities of enjoyment. Now the ſame principle, or law of our nature, which determines us to purſue any one end or ſpecies of good, prompts us to purſue every other end or ſpecies of good of which we are ſuſceptible, or to which our Maker has adapted an original propenſion. But, amidſt the great multiplicity of *ends* or *goods* which form the various ingredients of our happineſs, we perceive an evident *gradation* or *ſubordination* ſuited to that gradation of *ſenſes*, *powers*, and *paſſions*, which prevails in our mixed and various conſtitution, and to that aſcending ſeries of connections which open upon us in the different ſtages of our progreſſive ſtate.

90 Gradation of goods.

Thus the goods of the *body*, or of the *external ſenſes*, ſeem to hold the loweſt rank in this gradation or ſcale of goods. Theſe we have in common with the brutes; and though many men are brutiſh enough to purſue the goods of the body with a more than brutal fury, yet, when at any time they come in competition with goods of an higher order, the unanimous verdict of mankind, by giving the laſt the preference, condemns the firſt to the meaneſt place. Goods conſiſting in exterior ſocial connections, as *fame*, *fortune*, *power*, civil

civil authority, ſeem to ſucceed next, and are chiefly valuable as the means of procuring *natural* or *moral* good, but principally the latter. Goods of the *intellect* are ſtill ſuperior, as *taſte*, *knowledge*, *memory*, *judgment*, &c. The higheſt are moral goods of the mind, directly and ultimately regarding ourſelves, as *command of the appetites* and *paſſions*, *prudence*, *fortitude*, *benevolence*, &c. Theſe are the great objects of our purſuit, and the principal ingredients of our happineſs. Let us conſider each of them as they riſe one above the other in this natural ſeries or ſcale, and touch briefly on our obligations to purſue them.

91 Goods of the body. Thoſe of the body are *health*, *ſtrength*, *agility*, *hardineſs*, and *patience of change*, *neatneſs*, and *decency*.

92 Good health. Good health, and a regular eaſy flow of ſpirits, are in themſelves ſweet natural enjoyments, a great fund of pleaſure, and indeed the proper ſeaſoning which gives a flavour and poignancy to every other pleaſure. The want of health unfits us for moſt duties of life, and is eſpecially an enemy to the ſocial and human affections, as it generally renders the unhappy ſufferer peeviſh and ſullen, diſguſted at the allotments of providence, and conſequently apt to entertain ſuſpicious and gloomy ſentiments of its Author. It obſtructs the free exerciſe and full improvement of our reaſon, makes us a burden to our friends, and uſeleſs to ſociety. Whereas the uninterrupted enjoyment of good health is a conſtant ſource of good humour, and good humour is a great friend to openneſs and benignity of heart, enables us to encounter the various ills and diſappointments of life with more courage, or to ſuſtain them with more patience; and, in ſhort, conduces much, if we are otherwiſe duly qualified, to our acting our part in every exigency of life with more firmneſs, conſiſtency, and dignity. Therefore it imports us much to preſerve and improve an habit or enjoyment, without which every other external entertainment is taſteleſs, and moſt other advantages of little avail.

93 How preſerved. And this is beſt done by a ſtrict temperance in diet and regimen, by regular exerciſe, and by keeping the mind ſerene and unruffled by violent paſſions, and unſubdued by intenſe and conſtant labours, which greatly impair and gradually deſtroy the ſtrongeſt conſtitutions.

94 Strength, agility, &c. *Strength*, *agility*, *hardineſs*, and *patience of change*, ſuppoſe health, and are unattainable without it; but they imply ſomething more, and are neceſſary to guard it, to give us the perfect uſe of life and limbs, and to ſecure us againſt many otherwiſe unavoidable ills. The exerciſe of the neceſſary manual, and of moſt of the elegant arts of life, depends on ſtrength and agility of body; perſonal dangers, private and public dangers, the demands of our friends, our families, and country, require them; they are neceſſary in war, and ornamental in peace; fit for the employment of a country and a town life, and they exalt the entertainments and diverſions of both.

95 How attained. They are chiefly obtained by moderate and regular exerciſe.

96 Patience of change. Few are ſo much raiſed above want and dependence, or ſo exempted from buſineſs and care, as not to be often expoſed to inequalities and changes of diet, exerciſe, air, climate, and other irregularities. Now, what can be ſo effectual to ſecure one againſt the miſchiefs ariſing from ſuch unavoidable alterations, as hardineſs, and a certain verſatility of conſtitution which can bear extraordinary labours, and ſubmit to great changes, without any ſenſible uneaſineſs or bad conſequences.

97 How attained. This is beſt attained, not by an over-great delicacy and minute attention to forms, or by an invariable regularity in diet, hours, and way of living, but rather by a bold and diſcreet latitude of regimen. Beſides, deviations from eſtabliſhed rules and forms of living, if kept within the bounds of ſobriety and reaſon, are friendly to thought and original ſentiments, animate the dull ſcene of ordinary life and buſineſs, and agreeably ſtir the paſſions, which ſtagnate or breed ill-humour in the calms of life.

98 Neatneſs, decency, &c. *Neatneſs*, *cleanlineſs*, and *decency*, to which we may add *dignity* of *countenance*, and *demeanour*, ſeem to have ſomething refined and moral in them: at leaſt we generally eſteem them indications of an orderly, genteel, and well-governed mind, conſcious of an inward worth, or the reſpect due to one's nature. Whereas *naſtineſs*, *ſlovenlineſs*, *aukwardneſs*, and *indecency*, are ſhrewd ſymptoms of ſomething mean, careleſs, and deficient, and betray a mind untaught, illiberal, unconſcious of what is due to one's ſelf or to others. How much cleanlineſs conduces to health, needs hardly to be mentioned; and how neceſſary it is to maintain one's character and rank in life, and to render us agreeable to others as well as to ourſelves, is as evident.—There are certain motions, airs, and geſtures, which become the human countenance and form, in which we perceive a *comelineſs*, *openneſs*, *ſimplicity*, *gracefulneſs*; and there are others, which to our ſenſe of decorum appear *uncomely*, *affected*, *diſingenuous*, and *aukward*, quite unſuitable to the native dignity of our face and form. The *firſt* are in themſelves the moſt eaſy, natural, and commodious, give one boldneſs and preſence of mind, a modeſt aſſurance, an addreſs both awful and alluring; they beſpeak candour and greatneſs of mind, raiſe the moſt agreeable prejudices in one's favour, render ſociety engaging, command reſpect, and often love, and give weight and authority both in converſation and buſineſs; in fine, they are the colouring of virtue, which ſhew it to the greateſt advantage in whomſoever it is; and not only imitate, but in ſome meaſure ſupply it where it is wanting. Whereas the laſt, *viz* *rudeneſs*, *affectation*, *indecorum*, and the like, have all the contrary effects; they are burdenſome to one's ſelf, a diſhonour to our nature, and a nuiſance in ſociety.

99 How attained. The former qualities or goods are beſt attained by a liberal education, by preſerving a juſt ſenſe of the dignity of our nature, by keeping the beſt and politeſt company, but, above all, by acquiring thoſe virtuous and ennobling habits of mind which are decency in perfection, which will give an air of unaffected grandeur, and ſpread a luſtre truly engaging over the whole form and deportment.

100 Goods of exterior ſocial connections. We are next to conſider theſe goods which conſiſt in exterior ſocial connections, as *fame*, *fortune*, *civil authority*, *power*.

101 Fame. The firſt has a two-fold aſpect, as a good pleaſant in itſelf, or gratifying to an original paſſion, and then as expedient or uſeful towards a farther end. Honour from the wiſe and good, on the account of a virtuous conduct, is regaling to a good man; for then his heart re-

re-echoes to the grateful ſound. There are few quite indifferent even to the commendation of the vulgar. Though we cannot approve that conduct which proceeds entirely from this principle, and not from good affection or love of the conduct itſelf, yet, as it is often a guard and additional motive to virtue in creatures imperfect as we are, and often diſtracted by interfering paſſions, it might be dangerous to ſuppreſs it altogether, however wiſe it may be to reſtrain it within due bounds, and however laudable to uſe it only as a ſcaffolding to our virtue, which may be taken down when that glorious ſtructure is finiſhed, but hardly till then. To purſue fame for itſelf, is innocent; to regard it only as an auxiliary to virtue, is noble; to ſeek it chiefly as an engine of public uſefulneſs, is ſtill more noble, and highly praiſe-worthy. For though the opinion and breath of men are tranſient and fading things, often obtained without merit, and loſt without cauſe; yet as our buſineſs is with men, and as our capacity of ſerving them is generally increaſed in proportion to their eſteem of us, therefore ſound and well-eſtabliſhed *moral* applauſe may, and will be modeſtly, not oſtentatiouſly, ſought after by the *good;* not indeed as a ſolitary refined ſort of luxury, but as a public and proper inſtrument to ſerve and bleſs mankind. At the ſame time they will learn to deſpiſe that reputation which is founded on rank, fortune, and any other circumſtances or accompliſhments that are foreign to real merit, or to uſeful ſervices done to others, and think that praiſe of little avail which is purchaſed without deſert, and beſtowed without judgment.

102 Fortune, Power, &c. *Fortune, power,* and *civil authority,* or whatever is called influence and weight among mankind, are *goods* of the *ſecond* diviſion, that is, valuable and purſuable only as they are *uſeful,* or as means to a farther end, *viz.* procuring or preſerving the immediate objects of enjoyment or happineſs to ourſelves or others. Therefore to love ſuch goods on their own account, and to purſue them as ends, not the means of enjoyment, muſt be highly prepoſterous and abſurd. There can be no meaſure, no limit, to ſuch purſuit; all muſt be whim, caprice, extravagance. Accordingly ſuch appetites, unlike all the *natural* ones, are increaſed by poſſeſſion, and whetted by enjoyment. They are always precarious, and never without fears, becauſe the objects lie without one's ſelf; they are ſeldom without ſorrow and vexation, becauſe no acceſſion of wealth or power can ſatisfy them.
103 How far purſuable. But if thoſe goods are conſidered only as the materials or means of private or public happineſs, then the ſame obligations which bind us to purſue the latter, bind us likewiſe to purſue the former. We may, and no doubt we ought, to ſeek ſuch a meaſure of wealth as is neceſſary to ſupply all our real wants, to raiſe us above ſervile dependence, and provide us with ſuch conveniencies as are ſuited to our rank and condition in life. To be regardleſs of this meaſure of wealth, is to expoſe ourſelves to all the temptations of poverty and corruption; to forfeit our natural independency and freedom; to degrade, and conſequently to render the rank we hold, and the character we ſuſtain in ſociety, uſeleſs, if not contemptible. When theſe important ends are ſecured, we ought not to murmur or repine that we poſſeſs no more; yet we are not ſecluded by any obligation, moral or divine, from ſeeking more, in order to give us that happieſt and moſt god-like of all powers, the *power* of *doing good.* A ſupine indolence in this reſpect is both abſurd and criminal; *abſurd,* as it robs us of an inexhauſted fund of the moſt refined and durable enjoyments; and *criminal,* as it renders us ſo far uſeleſs to the ſociety to which we belong. "That purſuit of wealth which
"goes beyond the former end, *viz.* the obtaining the 104 Avarice.
"neceſſaries, or ſuch conveniencies of life, as, in the "eſtimation of reaſon, not of vanity or paſſion, are "ſuited to our rank and condition, and yet is not directed to the latter, *viz.* the doing good is what we "call *avarice.*" And "that purſuit of *power,* which,
"after ſecuring one's ſelf, *i. e.* having attained the 105 Ambition.
"proper independence and liberty of a rational ſocial "creature, is not directed to the good of others, is "what we call *ambition,* or the *luſt of power.*" To what extent the ſtrict meaſures of virtue will allow us to purſue either wealth or power, and civil authority, is not perhaps poſſible preciſely to determine. That muſt be left to prudence, and the peculiar character, condition, and other circumſtances of each man. Only thus far a limit may be ſet, that the purſuit of either muſt encroach upon no other duty or obligation which we owe to ourſelves, to ſociety, or to its parent and head. The ſame reaſoning is to be applied to *power* as to *wealth.* It is only valuable as an inſtrument of our own ſecurity, and of the free enjoyment of thoſe original goods it may, and often does, adminiſter to us, and, as an engine of more extenſive happineſs to our friends, our country, and mankind.

Now the beſt, and indeed the only way to obtain a 106 How fame and power are attained.
ſolid and laſting fame, is an uniform inflexible courſe of virtue, the employing one's ability and wealth in ſupplying the wants, and uſing one's power in promoting or ſecuring the happineſs, the rights and liberties of mankind, joined to an univerſal affability and politeneſs of manners. And ſurely one will not miſtake the matter much, who thinks the ſame courſe conducive to the acquiring greater acceſſions both of wealth and power; eſpecially if he adds to thoſe qualifications a vigorous induſtry, a conſtant attention to the characters and wants of men, to the conjunctures of times, and continually-varying genius of affairs; and a ſteady intrepid honeſty, that will neither yield to the allurements, nor be over-awed with the terrors, of that corrupt and corrupting ſcene in which we live. We have ſometimes heard indeed of other ways and means, as fraud, diſſimulation, ſervility, and proſtitution, and the like ignoble arts, by which the men of the world (as they are called, ſhrewd politicians, and men of addreſs!) amaſs wealth, and procure power: but as we want rather to form a man of virtue, an honeſt, contented, happy man, we leave to the men of the world their own ways, and permit them, unenvied and unimitated by us, to reap the fruit of their doings.

The next ſpecies of objects in the ſcale of good, are 107 Good of the intellect.
the goods of the *intellect,* as *knowledge, memory, judgment, taſte, ſagacity, docility,* and whatever elſe we call *intellectual* virtues. Let us conſider them a little, and the *means* as well as *obligations* to improve them.

As *man* is a *rational* creature, capable of knowing 108 Their moment.
the differences of things and actions;—as he not only ſees

sees and feels what is present, but remembers what is past, and often foresees what is future;—as he advances from small beginnings, by slow degrees, and with much labour and difficulty, to knowledge and experience:—as his opinions sway his passions,—as his passions influence his conduct,—and as his conduct draws consequences after it, which extend not only to the present, but to the future time, and therefore is the principal source of his happiness or misery; it is evident, that he is formed for intellectual improvements, and that it must be of the utmost consequence for him to improve and cultivate his intellectual powers, on which those opinions, those passions, and that conduct depend*.

* *Philos. Sinic. Confuc.* lib. I. § 3, 4, *&c.*

109 The pleasures they give.

But, besides the future consequences and moment of improving our *intellectual* powers, their immediate exercise on their proper objects yields the most rational and refined pleasures.

110 Knowledge and taste.

Knowledge, and a right taste in the arts of *imitation* and *design*, as *poetry*, *painting*, *sculpture*, *music*, *architecture*, afford not only an innocent, but a most sensible and sublime entertainment. By these the understanding is instructed in ancient and modern life, the history of men and things, the energies and effects of the passions, the consequences of virtue and vice; by these the imagination is at once entertained and nourished with the beauties of nature and art, lighted up and spread out with the novelty, grandeur, and harmony of the universe; and, in fine, the passions are agreeably roused, and suitably engaged, by the greatest and most interesting objects that can fill the human mind. He who has a taste formed to these ingenious delights, and plenty of materials to gratify it, can never want the most agreeable exercise and entertainment, nor once have reason to make that fashionable complaint of the tediousness of time. Nor can he want a proper subject for the discipline and improvement of his heart. For, being daily conversant with *beauty*, *order*, and *design*, in inferior subjects, he bids fair for growing in due time an admirer of what is fair and well-proportioned in the conduct of life and the order of society, which is only *order* and *design* exerted in their highest subject. He will learn to transfer the numbers of poetry to the harmony of the mind and of well-governed passions; and, from admiring the virtues of others in moral paintings, come to approve and imitate them himself. Therefore to cultivate a *true* and *correct taste*, must be both our *interest* and our *duty*, when the circumstances of our station give leasure and opportunity for it, and when the doing it is not inconsistent with our higher obligations or engagements to society and mankind.

111 How attained.

It is best attained by reading the best books, where *good sense* has more the ascendant than *learning*, and which pertain more to *practice* than to *speculation*; by studying the best models, *i. e.* those which profess to imitate nature most, and approach the nearest to it, and by conversing with men of the most refined taste, and the greatest experience in life.

112 Moment of intellectual goods.

As to the other intellectual goods, what a fund of entertainment must it be to investigate the truth and various relations of things, to trace the operations of nature to general laws, to explain by these its manifold phænomena, to understand that order by which the universe is upheld, and that œconomy by which it is governed; to be acquainted with the human mind, the connections, subordinations, and uses of its powers, and to mark their energy in life! how agreeable to the ingenious inquirer, to observe the manifold relations and combinations of individual minds in society, to discern the causes why they flourish or decay; and from thence to ascend, through the vast scale of beings, to that general mind which presides over all, and operates unseen in every system and in every age, through the whole compass and progression of nature! devoted to such entertainments as these, the contemplative have abandoned every other pleasure, retired from the body, so to speak, and sequestered themselves from social intercourse; for these, the *busy* have often preferred to the hurry and din of life the calm retreats of contemplation; for these, when once they came to taste them, even the *gay* and *voluptuous* have thrown up the lawless pursuits of sense and appetite, and acknowledged these mentual enjoyments to be the most *refined*, and indeed the *only* luxury. Besides, by a just and large knowledge of nature, we recognize the perfections of its author; and thus piety, and all those pious affections which depend on just sentiments of his character, are awakened and confirmed; and a thousand superstitious fears, that arise from partial views of his nature and works, will of course be excluded. An extensive prospect of human life, and of the periods and revolutions of human things, will conduce much to the giving a certain greatness of mind, and a noble contempt to those little competitions about power, honour, and wealth, which disturb and divide the bulk of mankind; and promote a calm indurance of those inconveniencies and ills that are the common appendages of humanity. Add to all, that a just knowledge of human nature, and of those hinges upon which the business and fortunes of men turn, will prevent our thinking either too highly or too meanly of our fellow-creatures, give no small scope to the exercise of friendship, confidence, and good-will, and at the same time brace the mind with a proper caution and distrust, those nerves of prudence, and give a greater mastery in the conduct of private as well as public life. Therefore, by cultivating our intellectual abilities, we shall best promote and secure our interest, and be qualified for acting our part in society with more honour to ourselves, as well as advantage to mankind. Consequently, to improve them to the utmost of our power is our duty; they are talents committed to us by the almighty Head of society, and we are accountable to him for the use of them.

The intellectual virtues are best improved by accurate and impartial observation, extensive reading, and unconfined converse with men of all characters, especially with those who, to private study, have joined the widest acquaintance with the world, and greatest praictce in affairs; but, above all, by being much in the world, and having large dealings with mankind. Such opportunities contribute much to divest one of prejudices and a servile attachment to crude systems, to open one's views, and to give that experience on which the most useful, because the most practical knowledge is built, and from which the surest maxims for the conduct of life are deduced. 113 How attained.

The highest goods which enter into the composition 114 Moral of goods.

of human happineſs are *moral* goods of the mind, directly and ultimately regarding ourſelves; as *command of the appetites and paſſions, prudence and caution, magnanimity, fortitude, humility, love of virtue, love of God, reſignation*, and the like. Theſe ſublime goods are goods by way of eminence, goods recommended and enforced by the moſt intimate and awful ſenſe and conſciouſneſs of our nature; goods that conſtitute the quinteſſence, the very temper of happineſs, that form and complection of ſoul which renders us approvable and lovely in the ſight of God; goods, in fine, which are the elements of all our future perfection and felicity.

115 Their moment.

Moſt of the other goods we have conſidered depend partly on ourſelves, and partly on accidents which we can neither foreſee nor prevent, and reſult from cauſes which we cannot influence or alter. They are ſuch goods as we may poſſeſs to-day and loſe to-morrow, and which require a felicity of conſtitution, and talents to attain them in full vigour and perfection, and a felicity of conjunctures to ſecure the poſſeſſion of them. Therefore, did our happineſs depend altogether or chiefly on ſuch tranſitory and precarious poſſeſſions, it were itſelf moſt precarious, and the higheſt folly to be anxious about it.——But though creatures, conſtituted as we are, cannot be indifferent about ſuch goods, and muſt ſuffer in ſome degree, and conſequently have our happineſs incomplete without them, yet they weigh but little in the ſcale when compared with moral goods. By the benevolent conſtitution of our nature theſe are placed within the ſphere of our activity, ſo that no man can be deſtitute of them unleſs he is firſt wanting to himſelf. Some of the wiſeſt and beſt of mankind have wanted moſt of the former goods, and all the external kind, and felt moſt of the oppoſite ills, ſuch at leaſt as ariſe from without; yet by poſſeſſing the latter, *viz.* the moral goods, have declared they were happy; and to the conviction of the moſt impartial obſervers have appeared happy. The worſt of men have been ſurrounded with every outward good and advantage of fortune, and have poſſeſſed great parts; yet, for want of moral rectitude, have been, and have confeſſed themſelves, notoriouſly and exquiſitely miſerable. The exerciſe of virtue has ſupported its votaries, and made them exult in the midſt of tortures almoſt intolerable; nay, how often has ſome falſe form or ſhadow of it ſuſtained even the greateſt * villains and bigots under the ſame preſſures! But no external goods, no goods of fortune, have been able to alleviate the agonies or expel the fears of a guilty mind, conſcious of the deſerved hatred and reproach of mankind, and the juſt diſpleaſure of Almighty God.

116 The mixed condition of human life requires particular virtues.

As the preſent condition of human life is wonderfully chequered with good and ill, and as no height of ſtation, no affluence of fortune, can abſolutely inſure the good, or ſecure againſt the ill, it is evident that a great part of the comfort and ſerenity of life muſt lie in having our minds duly affected with regard to both, *i. e.* rightly attempered to the loſs of one and the ſufferance of the other. For it is certain that outward calamities derive their chief malignity and preſſure from the inward diſpoſitions with which we receive them. By managing theſe right, we may greatly abate that malignity and preſſure, and conſequently diminiſh the number, and weaken the moment, of the ills of life, if we ſhould not have it in our power to obtain a large ſhare of its goods. There are particularly three virtues which go to the forming this right temper towards ill, and which are of ſingular efficacy, if not totally to remove, yet wonderfully to alleviate, the calamities of life. Theſe are *fortitude*, or *patience*, *humility*, and *reſignation*.

117 Fortitude.

Fortitude is that calm and ſteady habit of mind which either moderates our fears, and enables us bravely to encounter the proſpect of ill, or renders the mind ſerene and invincible under its immediate preſſure. It lies equally diſtant from raſhneſs and cowardice; and though it does not hinder us from feeling, yet prevents our complaining or ſhrinking under the ſtroke. It always includes a generous contempt of, or at leaſt a noble ſuperiority to, thoſe precarious goods of which we can inſure neither the poſſeſſion nor continuance. The man therefore who poſſeſſes this virtue in this ample ſenſe of it, ſtands upon an eminence, and ſees human things below him; the tempeſt indeed may reach him, but he ſtands ſecure and collected againſt it upon the baſis of conſcious virtue, which the ſevereſt ſtorms can ſeldom ſhake, and never overthrow.

118 Humility.

Humility is another virtue of high rank and dignity, though often miſtaken by proud mortals for meanneſs and puſillanimity. It is oppoſed to *pride*, which commonly includes in it a falſe or over-rated eſtimation of our own merit, an aſcription of it to ourſelves as its only and original cauſe, an undue compariſon of ourſelves with others, and, in conſequence of that ſuppoſed ſuperiority, an arrogant preference of ourſelves, and a ſupercilious contempt of them. *Humility*, on the other hand, ſeems to denote that modeſt and ingenuous temper of mind, which ariſes from a juſt and equal eſtimate of our own advantages compared with thoſe of others, and from a ſenſe of our deriving all originally from the Author of our being. Its ordinary attendants are mildneſs, a gentle forbearance, and an eaſy unaſſuming humanity with regard to the imperfections and faults of others; virtues rare indeed, but of the faireſt complection, the proper offspring of ſo lovely a parent, the beſt ornaments of ſuch imperfect creatures as we are, precious in the ſight of God, and which ſweetly allure the hearts of men.

119 Reſignation

Reſignation is that mild and heroic temper of mind which ariſes from a ſenſe of an infinitely wiſe and good providence, and enables one to acquieſce with a cordial affection in its juſt appointments. This virtue has ſomething very peculiar in its nature, and ſublime in its efficacy. For it teaches us to bear ill not only with patience, and as being unavoidable, but it transforms, as it were, ill into good, by leading us to conſider it, and every event that has the leaſt appearance of ill, as a divine diſpenſation, a wiſe and benevolent temperament of things, ſubſervient to univerſal good, and, of courſe, including that of every individual, eſpecially of ſuch as calmly ſtoop to it. In this light, the

* As Ravilliac, who aſſaſſinated Henry the fourth of France; and Balthaſar Geraerd, who murdered William the Firſt, prince of Orange.

the adminiſtration itſelf, nay every act of it, becomes an object of affection, the evil diſappears, or is converted into a balm which both heals and nouriſheth the mind. For, though the firſt unexpected acceſs of ill may ſurpriſe the ſoul into grief, yet that grief, when the mind calmly reviews its object, changes into contentment, and is by degrees exalted into veneration and a divine compoſure. Our private will is loſt in that of the Almighty, and our ſecurity againſt every real ill reſts on the ſame bottom as the throne of him who lives and reigns for ever.

120 *Chief good, objective and formal.* Before we finiſh this ſection, it may be fit to obſerve, that as the Deity is the ſupreme and inexhauſted ſource of good, on whom the happineſs of the whole creation depends; as he is the higheſt object in nature, and the only object who is fully proportioned to the *intellectual* and *moral* powers of the mind, in whom they ultimately reſt, and find their moſt perfect exerciſe and completion, he is therefore termed the *Chief good of man, objectively* conſidered. And *virtue*, or the proportioned and vigorous exerciſe of the ſeveral powers and affections on their reſpective objects, as above deſcribed, is, in the ſchools, termed the *chief good, formally* conſidered, or its *formal* idea, being the inward temper and native conſtitution of human happineſs.

From the detail we have gone through, the following corollaries may be deduced.

121 Corollaries. *Firſt*, It is evident, that the happineſs of ſuch a *progreſſive* creature as man can never be at a ſtand, or continue a fixed invariable thing. His finite nature, let it riſe ever ſo high, admits ſtill higher degrees of improvement and perfection. And his progreſſion in improvement or virtue always makes way for a progreſſion in happineſs. So that no poſſible point can be aſſigned in any period of his exiſtence in which he is perfectly happy, that is, ſo happy as to exclude higher degrees of happineſs. All his perfection is only comparative. 2. It appears that many things muſt conſpire to complete the happineſs of ſo *various* a creature as man, ſubject to ſo many wants, and ſuſceptible of ſuch different pleaſures. 3. As his capacities of pleaſure cannot be all gratified at the ſame time, and muſt often interfere with each other in ſuch a precarious and fleeting ſtate as human life, or be frequently diſappointed, perfect happineſs, *i. e.* the undiſturbed enjoyment of the ſeveral pleaſures of which we are capable, is unattainable in our preſent ſtate. 4. That ſtate is moſt to be ſought after, in which the feweſt competitions and diſappointments can happen, which leaſt of all impairs any ſenſe of pleaſure, and opens an inexhauſted ſource of the moſt refined and laſting enjoyments. 5. That ſtate which is attended with all thoſe advantages, is a ſtate or courſe of virtue. 6. *Therefore*, a ſtate of *virtue*, in which the moral goods of the mind are attained, is the *happieſt ſtate*.

CHAP. III.

Duties to SOCIETY.

SECT. I. *Filial and Fraternal Duty.*

As we have followed the order of nature in tracing the hiſtory of man, and thoſe duties which he owes to himſelf, it ſeems reaſonable to take the ſame method with thoſe he owes to ſociety, which conſtitute the *ſecond* claſs of his *obligations*.

122 Connection of parents. His parents are among the earlieſt objects of his attention; he becomes ſooneſt acquainted with them, repoſes a peculiar confidence in them, and ſeems to regard them with a fond affection, the early prognoſtics of his future *piety* and *gratitude*. Thus does nature dictate the firſt lines of filial duty, even before a juſt ſenſe of the connection is formed. But when the child is grown up, and has attained to ſuch a degree of underſtanding, as to comprehend the *moral tie*, and be ſenſible of the obligations he is under to his parents; when he looks back on their tender and diſintereſted affection, their inceſſant cares and labours in nurſing, educating, and providing for him, during that ſtate in which he had neither prudence nor ſtrength to care and provide for himſelf, he muſt be conſcious that he owes to them theſe peculiar duties.

123 Duties to parents. To reverence and honour them, as the inſtruments of nature in introducing him to life, and to that ſtate of comfort and happineſs which he enjoys; and therefore to eſteem and imitate their good qualities, to alleviate and bear with, and ſpread, as much as poſſible, a decent veil over their faults and weakneſſes.

2. To be highly grateful to them, for thoſe favours which it can hardly ever be in his power fully to repay; to ſhew this gratitude by a ſtrict attention to their wants, and a ſollicitous care to ſupply them; by a ſubmiſſive deference to their authority and advice, eſpecially by paying great regard to it in the choice of a wife, and of an occupation; by yielding to, rather than peeviſhly contending with, their humours, as remembering how oft they have been perſecuted by his; and, in fine, by ſoothing their cares, lightening their ſorrows, ſupporting the infirmities of age, and making the remainder of their life as comfortable and joyful as poſſible.

124 Duties to brethren and ſiſters. As his brethren and ſiſters are the next with whom the creature forms a *ſocial* and *moral* connection, to them he owes a *fraternal* regard; and with them ought he to enter into a ſtrict league of friendſhip, mutual ſympathy, advice, aſſiſtance, and a generous intercourſe of kind offices, remembering their relation to common parents, and that brotherhood of nature which unites them into a cloſer community of intereſt and affection.

SECT. II. *Concerning Marriage.*

125 Connection with the other ſex. WHEN man arrives to a certain age, he becomes ſenſible of a peculiar ſympathy and tenderneſs towards the other ſex; the charms of beauty engage his attention, and call forth new and ſofter diſpoſitions than he has yet felt. The many amiable qualities exhibited by a fair outſide, or by the mild allurement of female manners, or which the prejudiced ſpectator without much reaſoning ſuppoſes thoſe to include, with ſeveral other circumſtances both natural and accidental, point his view and affection to a particular object, and of courſe contract that general rambling regard, which was loſt and uſeleſs among the undiſtinguiſhed crowd, into a peculiar and permanent attachment to one woman, which ordinarily terminates in the moſt important, venerable, and delightful connection in life.

126 The grounds of this connection.

The ſtate of the brute creation is very different from that of human creatures. The former are cloathed and generally armed by their ſtructure, eaſily find what is neceſſary to their ſubſiſtence, and ſoon attain their vigour and maturity; ſo that they need the care and aid of their parents but for a ſhort while; and therefore we ſee that nature has aſſigned to them vagrant and tranſient amours. The connection being purely *natural*, and merely for propagating and rearing their offspring, no ſooner is that end anſwered, than the connection diſſolves of courſe. But the human race are of a more tender and defenceleſs conſtitution; their infancy and non-age continue longer; they advance ſlowly to ſtrength of body, and maturity of reaſon; they need conſtant attention, and a long ſeries of cares and labours, to train them up to decency, virtue, and the various arts of life. Nature has, therefore, provided them with the moſt affectionate and anxious tutors, to aid their weakneſs, to ſupply their wants, and to accompliſh them in thoſe neceſſary arts, even their own parents, on whom ſhe has devolved this mighty charge, rendered agreeable by the moſt alluring and powerful of all ties, parental affection. But unleſs both concur in this grateful taſk, and continue their joint labours, till they have reared up and planted out their young colony, it muſt become a prey to every rude invader, and the purpoſe of nature in the original union of the human pair be defeated. Therefore our ſtructure as well as condition is an evident indication, that the human ſexes are deſtined for a more intimate, for a moral and laſting union. It appears likewiſe, that the principal end of marriage is not to propagate and nurſe up an offspring, but to educate and form minds for the great duties and extenſive deſtinations of life. Society muſt be ſupplied from this original nurſery with uſeful members, and its faireſt ornaments and ſupports.

127 [128] Moral ends of marriage.

The mind is apt to be diſſipated in its views and acts of friendſhip and humanity; unleſs the *former* be directed to a particular object, and the *latter* employed in a particular province. When men once indulge to this diſſipation, there is no ſtopping their career, they grow inſenſible to moral attractions, and, by obſtructing or impairing the decent and regular exerciſe of the tender and generous feelings of the human heart, they in time become unqualified for, or averſe to, the forming a moral union of ſouls, which is the cement of ſociety, and the ſource of the pureſt domeſtic joys. Whereas a rational, undepraved *love*, and its fair companion, *marriage*, collect a man's views, guide his heart to its proper object, and, by confining his affection to that object, do really enlarge its influence and uſe. Beſides, it is but too evident from the conduct of mankind, that the common ties of humanity are too feeble to engage and intereſt the paſſions of the generality in the affairs of ſociety. The connections of neighbourhood, acquaintance, and general intercourſe, are too wide a field of action for many, and thoſe of a *public* or *community* are ſo for more; and in which they *either care not, or know not how* to exert themſelves. Therefore nature, ever wiſe and benevolent, by implanting that ſtrong ſympathy which reigns between the individuals of each ſex, and by urging them to form a particular moral connection, the ſpring of many domeſtic endearments, has meaſured out to each pair a particular *ſphere of action*, proportioned to their views, and adapted to their reſpective capacities. Beſides, by intereſting them deeply in the concerns of their own little circle, ſhe has connected them more cloſely with ſociety, which is compoſed of particular families, and bound them down to their good behaviour in that particular community to which they belong. This *moral connection* is *marriage*, and this *ſphere of action* is a *family*.

129 Duties of marriage.

Of the *conjugal* alliance the following are the *natural laws*. Firſt, mutual fidelity to the marriage-bed. Diſloyalty defeats the very end of marriage, diſſolves the natural cement of the relation, weakens the moral tie, the chief ſtrength of which lies in the reciprocation of affection; and, by making the offspring uncertain, diminiſhes the care and attachment neceſſary to their education.

2. A conſpiration of counſels and endeavours to promote the common intereſt of the family, and to educate their common offspring. In order to obſerve theſe laws, it is neceſſary to cultivate, both before and during the married ſtate, the ſtricteſt decency and chaſtity of manners, and a juſt ſenſe of what becomes their reſpective characters.

3. The union muſt be inviolable, and for life. The nature of friendſhip, and particularly of this ſpecies of it, the education of their offspring, and the order of ſociety and of ſucceſſions, which would otherwiſe be extremely perplexed, do all ſeem to require it. To preſerve this union, and render the matrimonial ſtate more harmonious and comfortable, a mutual eſteem and tenderneſs, a mutual deference and forbearance, a communication of advice, and aſſiſtance and authority, are abſolutely neceſſary. If either party keep within their proper departments, there need be no diſputes about power or ſuperiority, and there will be none. They have no *oppoſite*, no *ſeparate* intereſts, and therefore there can be no juſt ground for oppoſition of conduct.

130 [131] Polygamy.

From this detail, and the preſent ſtate of things, in which there is pretty near a parity of numbers of both ſexes, it is evident that *polygamy* is an *unnatural* ſtate; and though it ſhould be granted to be more fruitful of children, which however it is not found to be, yet it is by no means ſo fit for rearing minds, which ſeems to be as much, if not more, the intention of nature than the propagation of bodies.

Sect. III. *Of Parental Duty.*

132 Connection of parents and children.

The connection of parents with their children is a natural conſequence of the matrimonial connection; and the duties which they owe them reſult as naturally from that connection. The feeble ſtate of children, ſubject to ſo many wants and dangers, requires their inceſſant care and attention; their ignorant and uncultivated minds demand their continual inſtruction and culture. Had human creatures come into the world with the full ſtrength of *men* and the weakneſs of reaſon and vehemence of paſſions which prevail in *children*, they would have been too ſtrong or too ſtubborn to have ſubmitted to the government and inſtruction of their parents. But as they were deſigned for a progreſſion in knowledge and virtue, it was proper that

that the growth of their bodies ſhould keep pace with that of their minds, leſt the purpoſes of that progreſſion ſhould have been defeated. Among other admirable purpoſes which this gradual expanſion of their outward as well as inward ſtructure ſerves, this is one, that it affords ample ſcope to the exerciſe of many tender and generous affections, which fill up the domeſtic life with a beautiful variety of duties and enjoyments; and are of courſe a noble diſcipline for the heart, and an hardy kind of education for the more honourable and important duties of *public* life.

133 The authority founded on that connection. The above mentioned weak and ignorant ſtate of children, ſeems plainly to inveſt their parents with ſuch authority and power as is neceſſary to their ſupport, protection, and education; but that authority and power can be conſtrued to extend no farther than is neceſſary to anſwer thoſe ends, and to laſt no longer than that weakneſs and ignorance continue; wherefore, the foundation or reaſon of the authority and power ceaſing, they ceaſe of courſe. Whatever power or authority then it may be neceſſary or lawful for parents to exerciſe during the non-age of their children, to aſſume or uſurp the ſame when they have attained the maturity or full exerciſe of their ſtrength and reaſon would be tyrrannical and unjuſt. From hence it is evident, that parents have no right to puniſh the perſons of their children more ſeverely than the nature of their wardſhip requires, much leſs to invade their lives, to encroach upon their liberty, or transfer them as their property to any maſter whatſoever.

134 Duties of parents. The firſt claſs of duties which parents owe their children reſpect their natural life; and theſe comprehend protection, nurture, proviſion, introducing them into the world in a manner ſuitable to their rank and fortune, and the like.

135 Education. The ſecond order of duties regards the *intellectual* and *moral* life of their children, or their education in ſuch arts and accompliſhments as are neceſſary to qualify them for performing the duties they owe to themſelves and to others. As this was found to be the principal deſign of the matrimonial alliance, ſo the fulfilling that deſign is the moſt important and dignified of all the parental duties. In order therefore to fit the child for acting his part wiſely and worthily as a *man*, as a *citizen*, and a *creature of God*, both parents ought to combine their joint wiſdom, authority, and power, and each apart to employ thoſe talents which are the peculiar excellency and ornament of their reſpective ſex. The father ought to *lay out* and *ſuperintend* their education, the mother to execute and manage the detail of which ſhe is capable. The *former* ſhould direct the manly exertion of the intellectual and moral powers of his child. His imagination, and the manner of thoſe exertions, are the peculiar province of the *latter*. The *former* ſhould adviſe, protect, command, and, by his experience, maſculine vigour, and that ſuperior authority which is commonly aſcribed to his ſex, brace and ſtrengthen his pupil for *active* life, for gravity, integrity, and firmneſs in ſuffering. The buſineſs of the *latter* is to bend and ſoften her *male* pupil, by the charms of her converſation, and the ſoftneſs and decency of her manners for *ſocial* life, for politeneſs of taſte, and the elegant decorums and enjoyments of humanity; and to improve and refine the tenderneſs and modeſty of her *female* pupil, and form her to all thoſe mild domeſtic virtues which are the peculiar characteriſtics and ornaments of her ſex. To conduct the opening minds of their ſweet charge through the ſeveral periods of their progreſs, to aſſiſt them in each period, in throwing out the latent ſeeds of reaſon and ingenuity, and in gaining freſh acceſſions of light and virtue; and at length, with all theſe advantages, to produce the young adventurers upon the great theatre of human life, to play their ſeveral parts in the ſight of their friends, of ſociety, and mankind!

SECT. IV. *Herile and Servile Duty.*

In the natural courſe of human affairs it muſt neceſſarily happen, that ſome of mankind will live in plenty and opulence, and others be reduced to a ſtate of indigence and poverty. The former need the labours of the latter, and the latter the proviſion and ſupport of the former. This mutual neceſſity is the foundation of that connection, whether we call it *moral* or *civil*, which ſubſiſts between maſters and ſervants. 136 The ground of this connection.

He who feeds another has a right to ſome equivalent, the labour of him whom he maintains, and the fruits of it. And he who labours for another has a right to expect that he ſhould ſupport him. But as the labours of a man of ordinary ſtrength are certainly of greater value than mere food and cloathing; becauſe they would actually produce more, even the maintenance of a family, were the labourer to employ them in his own behalf; therefore he has an undoubted right to rate and diſpoſe of his ſervice for certain wages above mere maintenance; and if he has incautiouſly diſpoſed of it for the latter only, yet the contract being of the *onerous* kind, he may equitably claim a ſupply of that deficiency. If the ſervice be ſpecified, the ſervice is bound to that only; if not, then he is to be conſtrued as bound only to ſuch ſervices as are conſiſtent with the laws of juſtice and humanity. By the voluntary ſervitude to which he ſubjects himſelf, he forfeits no rights by ſuch as are neceſſarily included in that ſervitude, and is obnoxious to no puniſhment but ſuch as a voluntary failure in the ſervice may be ſuppoſed reaſonably to require. *The offſpring of ſuch ſervants* have a right to that liberty which neither they nor their parents have forfeited. 137 The conditions of ſervice.

As to thoſe who, becauſe of ſome heinous offence, or for ſome notorious damage, for which they cannot otherwiſe compenſate, are condemned to perpetual ſervice, they do not, on that account, forfeit all the rights of men; but thoſe, the loſs of which is neceſſary to ſecure ſociety againſt the like offences for the future, or to repair the damage they have done. 138 The caſe of great offenders.

With regard to captives taken in war, it is barbarous and inhuman to make perpetual ſlaves of them, unleſs ſome peculiar and aggravated circumſtances of guilt have attended their hoſtility. The bulk of the ſubjects of any government engaged in war may be fairly eſteemed innocent enemies; and therefore they have a right to that clemency which is conſiſtent with the common ſafety of mankind, and the particular ſecurity of that ſociety againſt which they are engaged. 139 The caſe of captives.

Though ordinary captives have a grant of their lives, yet to pay their liberty as an equivalent is much too high a price. There are other ways of acknowledging or returning the favour, than by ſurrendering what is far dearer than life itſelf*. To thoſe who, under pretext of the neceſſities of commerce, drive the unnatural trade of bargaining for human fleſh, and conſigning their innocent but unfortunate fellow creatures to eternal ſervitude and miſery, we may addreſs the words of a fine writer; "Let avarice defend it as it "will, there is an honeſt reluctance in humanity a-"gainſt buying and ſelling, and regarding thoſe of "our own ſpecies as our wealth and poſſeſſions."

* *Hutcheſ. Mor. Inſt. Phil.* lib. 3. c. 3.

Sect. V. *Social Duties of the private Kind.*

Hitherto we have conſidered only the *domeſtic œconomical* duties, becauſe theſe are firſt in the progreſs of nature. But as man paſſes beyond the little circle of a family, he forms connections with relations, friends, neighbours, and others; from whence reſults a new train of duties of the more private ſocial kind, as *friendſhip, chaſtity, courteſy, good-neigbourhood, charity, forgiveneſs, hoſpitality.*

140 Man's aptitude for ſociety.

Man is admirably formed for particular ſocial attachments and duties. There is a peculiar and ſtrong propenſity in his nature to be affected with the ſentiments and diſpoſitions of others. Men, like certain muſical inſtruments, are ſet to each other, ſo that the vibrations or notes excited in one raiſe correſpondent notes and vibrations in the others. The impulſes of *pleaſure* or *pain, joy* or *ſorrow,* made on one mind, are by an inſtantaneous ſympathy of nature communicated in ſome degree to all; eſpecially when hearts are (as an humane writer expreſſes it) in *uniſon* of kindneſs; the joy that vibrates in one communicates to the other alſo. We may add, that though joy thus imparted ſwells the harmony, yet grief vibrated to the heart of a friend, and rebounding from thence in ſympathetic notes, melts as it were, and almoſt dies away. All the paſſions, but eſpecially thoſe of the ſocial kind, are contagious; and when the paſſions of one man mingle with thoſe of another, they increaſe and multiply prodigiouſly. There is a moſt moving eloquence in the human countenance, air, voice, and geſture, wonderfully expreſſive of the moſt latent feelings and paſſions of the ſoul, which darts them like a ſubtle flame into the hearts of others, and raiſes correſpondent feelings there: friendſhip, love, good-humour, joy, ſpread through every feature, and particularly ſhoot from the eyes their ſofter and fiercer fires with an irreſiſtible energy. And in like manner the oppoſite paſſions of hatred, enmity, ill-humour, melancholy, diffuſe a ſullen and ſaddening air over the face, and, flaſhing from eye to eye, kindle a train of ſimilar paſſions. By theſe, and other admirable pieces of machinery, men are formed for ſociety and the delightful interchange of friendly ſentiments and duties, to increaſe the happineſs of others by participation, and their own by rebound; and to diminiſh, by dividing the common ſtock of their miſery.

141 Duties ariſing from private relation.

The firſt emanations of the *ſocial* principle beyond the bounds of a family lead us to form a nearer conjunction of friendſhip or good-will with thoſe who are any wiſe connected with us by *blood*, or *domeſtic alliance*. To them our affection does commonly exert itſelf in a greater or leſs degree, according to the nearneſs or diſtance of the relation. And this proportion is admirably ſuited to the extent of our powers and the indigence of our ſtate; for it is only within thoſe leſſer circles of conſanguinity or alliance that the generality of mankind are able to diſplay their abilities or benevolence, and conſequently to uphold their connection with ſociety and ſubſerviency, to a public intereſt. Therefore it is our duty to regard theſe cloſer connections as the next department to that of a family, in which nature has marked out for us a ſphere of activity and uſefulneſs; and to cultivate the kind affections which are the cement of thoſe endearing alliances.

142 Ingredients of friendſhip.

Frequently the view of diſtinguiſhing moral qualities in ſome of our acquaintance may give birth to that more noble connection we call friendship, which is far ſuperior to the alliances of conſanguinity. For theſe are of a ſuperficial, and often of a tranſitory nature, of which, as they hold more of *inſtinct* than of *reaſon*, we cannot give ſuch a rational account. But *friendſhip* derives all its ſtrength and beauty, and the only exiſtence which is durable, from the qualities of the heart, or from virtuous and lovely diſpoſitions. Or, ſhould theſe be wanting, they or ſome ſhadow of them muſt be ſuppoſed preſent. Therefore *friendſhip* may be deſcribed to be, "The "union of two ſouls by means of *virtue*, the common "object and cement of their mutual affection." Without virtue, or the ſuppoſition of it, friendſhip is only a *mercenary* league, and alliance of intereſt, which muſt diſſolve of courſe when that intereſt decays or ſubſiſts no longer. It is not ſo much any particular paſſion, as a compoſition of ſome of the nobleſt feelings and paſſions of the mind. *Good ſenſe*, a *juſt taſte* and *love of virtue*, a *thorough candour* and *benignity of heart*, or what we uſually call a *good temper*, and a generous ſympathy of ſentiments and affections, are the neceſſary ingredients of this virtuous connection. When it is grafted on eſteem ſtrengthened by habit, and mellowed by time, it yields infinite pleaſure, ever new and ever growing, is a noble ſupport amidſt the various trials and viciſſitudes of life, and an high ſeaſoning to moſt of our other enjoyments. To form and cultivate virtuous friendſhip, muſt be very improving to the temper, as its principal *object* is *virtue*, ſet off with all the allurement of countenance, air, and manners, ſhining forth in the native graces of manly honeſt ſentiments and affections, and rendered *viſible* as it were to the friendly ſpectator in a conduct unaffectedly great and good; and as its principal exerciſes are the very energies of virtue, or its effect and emanations. So that wherever this amiable attachment prevails, it will exalt our admiration and attachment to virtue, and, unleſs impeded in its courſe by unnatural prejudices, run out into a friendſhip to the human race. For as no one can merit, and none ought to uſurp, the ſacred name of friend, who hates mankind; ſo whoever truly loves *them*, poſſeſſes the moſt eſſential quality of a true friend.

143 Its duties.

The duties of friendſhip are a mutual eſteem of each other, unbribed by intereſt, and independent of it, a generous

generous confidence as far distant from ſuſpicion as from reſerve, an inviolable harmony of ſentiments and diſpoſitions of deſigns and intereſts, a fidelity unſhaken by the changes of fortune, a conſtancy unalterable by diſtance of time or place, a reſignation of one's perſonal intereſt to thoſe of one's friend, and a reciprocal, unenvious, unreſerved exchange of kind offices.—But, amidſt all the exertions of this moral connection, humane and generous as it is, we muſt remember that it operates within a narrow ſphere, and its immediate operations reſpect only the individual; and therefore its particular impulſes muſt ſtill be ſubordinate to a more public intereſt, or be always directed and controlled by the more extenſive connections of our nature.

144 Love and chaſtity.

When our friendſhip terminates on any of the other ſex, in whom beauty or agreeableneſs of perſon and external gracefulneſs of manners conſpire to expreſs and heighten the moral charm of a tender honeſt heart, and ſweet, ingenuous modeſt temper, lighted up by good ſenſe; it generally grows into a more ſoft and endearing attachment. When this attachment is improved by a growing acquaintance with the worth of its object, is conducted by diſcretion, and iſſues at length, as it ought to do, in the moral connection formerly mentioned*, it becomes the ſource of many amiable duties, of a communication of paſſions and intereſts, of the moſt refined decencies, and of a thouſand nameleſs deep-felt joys of reciprocal tenderneſs and love, flowing from every look, word, and action. Here friendſhip acts with double energy, and the *natural* conſpires with the *moral* charms to ſtrengthen and ſecure the love of virtue. As the delicate nature of female honour and decorum, and the inexpreſſible grace of a chaſte and modeſt behaviour, are the ſureſt and indeed the only means of kindling at firſt, and ever after of keeping alive, this tender and elegant flame, and of accompliſhing the excellent ends deſigned by it; to attempt by fraud to violate one, or, under pretence of paſſion, to ſully and corrupt the other, and, by ſo doing, to expoſe the too often credulous and unguarded object, with a wanton cruelty, to the hatred of her own ſex and the ſcorn of ours, and to the loweſt infamy of both is a conduct not only baſe and criminal, but inconſiſtent with that truly rational and refined enjoyment, the ſpirit and quinteſſence of which is derived from the baſhful and ſacred charms of virtue kept untainted, and therefore ever alluring to the lover's heart.

* See Sect. iii. of this chapter.

145 Courteſy, good-neighbourhood, *&c.*

Courteſy, *good-neighbourhood*, *affability*, and the like duties, which are founded on our private ſocial connections, are no leſs neceſſary and obligatory to creatures united in ſociety, and ſupporting and ſupported by each other in a chain of mutual want and dependence. They do not conſiſt in a ſmooth addreſs, an artificial or obſequious air, fawning adulations, or a polite ſervility of manners; but in a juſt and modeſt ſenſe of our own dignity and that of others, and of the reverence due to mankind, eſpecially to thoſe who hold the higher links of the ſocial chain; in a diſcreet and manly accommodation of ourſelves to the foibles and humours of others; in a ſtrict obſervance of the rules of decorum and civility; but, above all, in a frank obliging carriage, and generous interchange of good deeds rather than words. Such a conduct is of great uſe and advantage, as it is an excellent ſecurity againſt injury, and the beſt claim and recommendation to the eſteem, civility, and univerſal reſpect of mankind. This inferior order of virtues unite the particular members of ſociety more cloſely, and forms the leſſer pillars of the civil fabric; which, in many inſtances, ſupply the unavoidable defects of laws, and maintain the harmony and decorum of ſocial intercourſe, where the more important and eſſential lines of virtue are wanting.

136 Charity, forgiveneſs.

Charity and *forgiveneſs* are truly amiable and uſeful duties of the ſocial kind. There is a twofold diſtinction of rights commonly taken notice of by moral writers, *viz. perfect* and *imperfect*. To fulfil the former, is neceſſary to the being and ſupport of ſociety; to fulfil the latter, is a duty equally ſacred and obligatory, and tends to the improvement and proſperity of ſociety; but as the violation of them is not equally prejudicial to the public good, the fulfilling them is not ſubjected to the cognizance of law, but left to the candour, humanity, and gratitude of individuals. And by this means ample ſcope is given to exerciſe all the generoſity, and diſplay the genuine merit and luſtre, of virtue. Thus the wants and misfortunes of others call for our charitable aſſiſtance and ſeaſonable ſupplies. And the good man, unconſtrained by law, and uncontrolled by human authority, will chearfully acknowledge and generouſly ſatisfy this mournful and moving claim; a claim ſupported by the ſanction of heaven, of whoſe bounties he is honoured to be the grateful truſtee. If his own *perfect* rights are invaded by the injuſtice of others, he will not therefore reject their *imperfect* right to pity and forgiveneſs, unleſs his grant of theſe ſhould be inconſiſtent with the more extenſive rights of ſociety, or the public good. In that caſe he will have recourſe to public juſtice and the laws, and even then he will proſecute the injury with no unneceſſary ſeverity, but rather with mildneſs and humanity. When the injury is merely perſonal, and of ſuch a nature as to admit of alleviations, and the forgiveneſs of which would be attended with no worſe conſequences, eſpecially of a public kind, the good man will generouſly forgive his offending brother. And it is his duty to do ſo, and not to take private revenge, or retaliate evil for evil. For though reſentment of injury is a natural paſſion, and implanted, as was obſerved † above, for wiſe and good ends; yet, conſidering the manifold partialities which moſt men have for themſelves, was every one to act as judge in his own cauſe, and to execute the ſentence dictated by his own reſentment, it is but too evident that mankind would paſs all bounds in their fury, and the laſt ſufferer be provoked in his turn to make full repriſals. So that evil, thus encountering with evil, would produce one continued ſeries of violence and miſery, and render ſociety intolerable, if not impracticable. Therefore, where the ſecurity of the individual, or the good of the public, does not require a proportionable retaliation, it is agreeable to the general law of benevolence, and to the particular end of the paſſion (which is to prevent injury and the miſery occaſioned by it) to forgive perſonal injuries, or not to return evil for evil. This duty is one of the noble refinements

† See Part I. chap. ii. and iv.

finements which *Chriſtianity* has made upon the general maxims and practice of mankind, and enforced, with a peculiar ſtrength and beauty, by ſanctions no leſs alluring than awful. And indeed the practice of it is generally its own reward; by expelling from the mind the moſt dreadful intruders upon its repoſe, thoſe rancorous paſſions which are begot and nurſed by reſentment, and, by diſarming, and even ſubduing, every enemy one has, except ſuch as have nothing left of men but the outward form.

147 Hoſpitality. The moſt enlarged and humane connection of the private kind ſeems to be the hoſpitable alliance, from which flow the amiable and diſintereſted duties we owe to ſtrangers. If the exerciſe of paſſions of the moſt private and inſtinctive kind is beheld with moral approbation and delight, how lovely and venerable muſt thoſe appear which reſult from a calm philanthropy, are founded in the common rights and connections of ſociety, and embrace men, not of a particular ſect, party, or nation, but all in general without diſtinction, and without any of the little partialities of ſelf-love.

SECT. VI. *Social duties of the* COMMERCIAL *kind.*

148 Commercial duties. THE next order of connections are thoſe which ariſe from the wants and weakneſs of mankind, and from the various circumſtances in which their different ſituations place them. Theſe we may call *commercial* connections, and the duties which reſult from them *commercial* duties, as *juſtice, fair-dealing, ſincerity, fidelity to compacts,* and the like.

149 Their foundation. Though nature is perfect in all her works, yet ſhe has obſerved a manifeſt and eminent diſtinction among them. To all ſuch as lie beyond the reach of human ſkill and power, and are properly of her own department, ſhe has given the finiſhing hand. Theſe man may deſign after and imitate, but he can never rival them, nor add to their beauty or perfection. Such are the forms and ſtructure of vegetables, animals, and many of their productions, as the honey-comb, the ſpider's web, and the like. There are others of her works which ſhe has of deſign left unfiniſhed, as it were, in order to exerciſe the ingenuity and power of man. She has preſented to him a rich profuſion of materials of every kind for his conveniency and uſe; but they are rude and unpoliſhed, or not to be come at without art and labour. Theſe therefore he muſt apply, in order to adapt them to his uſe, and to enjoy them in perfection. Thus nature has given him an infinite variety of herbs, grain, foſſils, minerals, wood, water, earth, air, and a thouſand other crude materials, to ſupply his numerous wants. But he muſt ſow, plant, dig, refine, poliſh, build, and, in ſhort, manufacture the various produce of nature, in order to obtain even the neceſſaries, and much more the conveniencies and elegancies of life. Theſe then are the price of his labour and induſtry, and, without that, nature will ſell him nothing. But as the wants of mankind are many, and the ſingle ſtrength of individuals ſmall, they could hardly find the neceſſaries, and much leſs the conveniencies of life, without uniting their ingenuity and ſtrength in acquiring theſe, and without a mutual intercourſe of good offices. Some men are better formed for ſome kinds of ingenuity and labour, and others for other kinds; and different ſoils and climates are enriched with different productions; ſo that men, by exchanging the produce of their reſpective labours, and ſupplying the wants of one country with the ſuperfluities of another, do, in effect, diminiſh the labours of each, and increaſe the abundance of all. This is the foundation of all commerce, or exchange of commodities and goods one with another; in order to facilitate which, men have contrived different ſpecies of coin, or money, as a common ſtandard by which to eſtimate the comparative values of their reſpective goods. But to render commerce ſure and effectual, *juſtice, fair-dealing, ſincerity,* and *fidelity to compacts,* are abſolutely neceſſary.

Juſtice or *fair-dealing;* or, in other words, a diſ- 150 Juſtice, *&c.*
poſition to treat others as we would be treated by them, is a virtue of the firſt importance, and inſeparable from the virtuous character. It is the cement of ſociety, or that pervading ſpirit which connects its members, inſpires its various relations, and maintains the order and ſubordination of each part to the whole. Without it, ſociety would become a den of thieves and banditti, hating and hated, devouring and devoured, by one another.

Sincerity, or *veracity,* in our words and actions, 151 Sincerity.
is another virtue or duty of great importance to ſociety, being one of the great bands of mutual intercourſe, and the foundation of mutual truſt. Without it, ſociety would be the dominion of miſtruſt, jealouſy, and fraud, and converſation a traffic of lies and diſſimulation. It includes in it a conformity of our words with our ſentiments, a correſpondence between our actions and diſpoſitions, a ſtrict regard to truth, and an irreconcileable abhorrence of falſehood. It does not indeed require, that we expoſe our ſentiments indiſcreetly, or tell all the truth in every caſe; but certainly it does not and cannot admit the leaſt violation of truth, or contradiction to our ſentiments. For if theſe bounds are once paſſed, no poſſible limit an be aſſigned where the violation ſhall ſtop; and no pretence of private or public good can poſſibly counterbalance the ill conſequences of ſuch a violation.

Fidelity to promiſes, compacts, and *engagements,* is 152 Fidelity to compacts, promiſes, *&c.*
likewiſe a duty of ſuch importance to the ſecurity of commerce and interchange of benevolence among mankind, that ſociety would ſoon grow intolerable without the ſtrict obſervance of it. *Hobbes,* and others who follow the ſame track, have taken a wonderful deal of pains to puzzle this ſubject, and to make all the virtues of this ſort merely *artificial,* and not at all *obligatory,* antecedent to human conventions. No doubt, compacts ſuppoſe people who make them; and promiſes, perſons to whom they are made; and therefore both ſuppoſe ſome ſociety, more or leſs, between thoſe who enter into theſe mutual engagements. But is not a compact or promiſe binding, till men have agreed that they ſhall be binding? or are they only binding, becauſe it is our intereſt to be bound by them, or to fulfil them? Do not we highly approve the man who fulfils them, even though they ſhould prove to be againſt his intereſt? and do not we condemn him as a knave who violates them on that account? a pro-

miſe is a voluntary declaration, by words, or by an action equally ſignificant, of our reſolution to do ſomething in behalf of another, or for his ſervice. When it is made, the perſon who makes it is by all ſuppoſed under an obligation to perform it. And he to whom it is made may demand the performance as his right. That perception of *obligation* is a ſimple idea, and is on the ſame footing as our other moral perceptions, which may be deſcribed by inſtances, but cannot be defined. Whether we have a perception of ſuch obligation quite diſtinct from the intereſt, either public or private, that may accompany the fulfilment of it, muſt be referred to the conſcience of every individual. And whether the mere ſenſe of that obligation, apart from its concomitants, is not a ſufficient inducement or motive to keep one's promiſe, without having recourſe to any ſelfiſh principle of our nature, muſt be likewiſe appealed to the conſcience of every honeſt man. *Fair-dealing* and *fidelity to compacts* require that we take no advantage of the ignorance, paſſion, or incapacity of others, from whatever cauſe that incapacity ariſes;—that we may be explicit and candid in making bargains, juſt and faithful in fulfilling our part of them. And if the other party violates his engagements, redreſs is to be ſought from the laws, or from thoſe who are intruſted with the execution of them. In fine, the *commercial* virtues and duties require that we not only do not evade, but maintain the rights of others;—that we be fair and impartial in transferring, bartering, or exchanging property, whether in goods or ſervice; and be inviolably faithful to our word and our engagements, where the matter of them is not criminal, and where they are not extorted by force.

Sect. VII. *Social Duties of the* Political *Kind.*

We are now arrived at the laſt and higheſt order of duties reſpecting ſociety, which reſult from the exerciſe of the moſt generous and heroic affections, and
152 are founded on our moſt enlarged connections.

Political connections.

The *ſocial* principle in man is of ſuch an expanſive nature, that it cannot be confined within the circuit of a family, of friends, or a neighbourhood; it ſpreads into wider ſyſtems, and draws men into larger confederacies, communities, and commonwealths. It is in theſe only that the higher powers of our nature attain the higheſt improvement and perfection of which they are capable. Theſe principles hardly find objects in the ſolitary ſtate of nature. *There* the principle of action riſes no higher at fartheſt than *natural affection* towards one's offspring. There perſonal or family wants intirely engroſs the creature's attention and labour, and allow no leiſure, or, if they did, no exerciſe for views and affections of a more enlarged kind. In *ſolitude* all are employed in the ſame way, in providing for the *animal* life. And even after their utmoſt labour and care, ſingle and unaided by the induſtry of others, they find but a ſorry ſupply of their wants, and a feeble, precarious ſecurity againſt dangers from wild beaſts; from inclement ſkies and ſeaſons; from the miſtakes or petulant paſſions of their fellow-creatures; from their preference of themſelves to their neighbours; and from all the little exorbitances of ſelf-love. But in *ſociety*, the mutual aids which men give and receive ſhorten the labours of each, and the combined ſtrength and reaſon of individuals give ſecurity and protection to the whole body. There is both a variety and ſubordination of genius among mankind. Some are formed to lead and direct others, to contrive plans of happineſs for individuals, and of government for communities, to take in a public intereſt, invent laws and arts, and ſuperintend their execution, and, in ſhort, to refine and civilize human life. Others, who have not ſuch good heads, may have as honeſt hearts, a truly public ſpirit, love of liberty, hatred of corruption and tyranny, a generous ſubmiſſion to laws, order, and public inſtitutions, and an extenſive philanthrophy. And others, who have none of thoſe capacities either of heart or head, may be well formed for manual exerciſes, and bodily labour. The former of theſe principles have no ſcope in ſolitude, where a man's thoughts and concerns do all either centre in himſelf, or extend no farther than a family; into which little circle all the duty and virtue of the ſolitary mortal is crowded. But ſociety finds proper objects and exerciſes for every genius, and the nobleſt objects and exerciſes for the nobleſt geniuſes, and for the higheſt principles in the human conſtitution; particularly for that warmeſt and moſt divine paſſion which God hath kindled in our boſoms, the inclination of doing good, and reverencing our nature; which may find here both employment, and the moſt exquiſite ſatisfaction. In ſociety, a man has not only more leiſure, but better opportunities, of applying his talents with much greater perfection and ſucceſs, eſpecially as he is furniſhed with the joint advice and aſſiſtance of his fellow-creatures, who are now more cloſely united one with the other, and ſuſtain a common relation to the ſame moral ſyſtem or community. This then is an object proportioned to his moſt enlarged ſocial affections, and in ſerving it he finds ſcope for the exerciſe and refinement of his higheſt intellectual and moral powers. *Therefore ſociety, or a ſtate of civil government*, reſts on theſe two principal pillars, "That in it we find ſecurity "againſt thoſe evils which are unavoidable in ſolitude "—and obtain thoſe goods, ſome of which cannot be "obtained at all, and others not ſo well, in that ſtate "where men depend ſolely on their individual ſaga- "city and induſtry."

From this ſhort detail it appears, that *man* is a *ſocial* creature, and formed for a *ſocial* ſtate; and that *ſociety*, being adapted to the higher principles and deſtinations of his nature, muſt of neceſſity be his *natural* ſtate.

The duties ſuited to that ſtate, and reſulting from 154
Political duties.

thoſe principles and deſtinations, or, in other words, from our ſocial paſſions and ſocial connections, or relation to a public ſyſtem, are, *love of our country, reſignation and obedience to the laws, public ſpirit, love of liberty, ſacrifice of life and all to the public*, and the like.

Love of our country, is one of the nobleſt paſſions 155
Love of one's country.

that can warm and animate the human breaſt. It includes all the limited and particular affections to our parents, friends, neighbours, fellow-citizens, countrymen. It ought to direct and limit their more confined and partial actions within their proper and natural bounds, and never let them incroach on thoſe ſacred and

and first regards we owe to the great public to which we belong. Were we solitary creatures, detached from the rest of mankind, and without any capacity of comprehending a *public interest*, or without affections leading us to desire and pursue it, it would not be our duty to mind it, nor criminal to neglect it. But as we are PARTS of the *public system*, and are not only capable of taking in large views of its interests, but by the strongest affections connected with it, and prompted to take a share of its concerns, we are under the most sacred ties to prosecute its security and welfare with the utmost ardour, especially in times of public trial. This *love of our country* does not import an attachment to any particular soil, climate, or spot of earth, where perhaps we first drew our breath, though those *natural* ideas are often associated with the *moral* ones; and, like external signs or symbols, help to ascertain and bind them; but it imports an affection to that *moral system*, or *community*, which is governed by the same laws and magistrates, and whose several parts are variously connected one with the other, and all united upon the bottom of a common interest. Perhaps indeed every member of the community cannot comprehend so large an object, especially if it extends through large provinces, and over vast tracts of land; and still less can he form such an idea, if there is no *public*, *i. e.* if all are subject to the caprice and unlimited will of one man; but the preference the generality shew to their native country; the concern and longing after it which they express, when they have been long absent from it; the labours they undertake, and sufferings they endure, to save or serve it; and the peculiar attachment they have to their countrymen; evidently demonstrate that the passion is *natural*, and never fails to exert itself when it is fairly disengaged from foreign clogs, and is directed to its proper object. Wherever it prevails in its genuine vigour and extent, it swallows up all sordid and selfish regards, it conquers the love of *ease*, *power*, *pleasure*, and *wealth*; nay, when the amiable partialities of *friendship*, *gratitude*, *private affection*, or *regards to a family*, come in competition with it, it will teach us bravely to sacrifice all, in order to maintain the rights, and *promote* or *defend* the honour and happiness of our country.

156 Resignation and obedience to the laws, &c.

Resignation and *obedience to the laws* and *orders* of the society to which we belong, are *political* duties necessary to its very being and security, without which it must soon degenerate into a state of licence and anarchy. The welfare, nay, the nature of civil society, requires, that there should be a subordination of orders, or diversity of ranks and conditions in it;—that certain men, or orders of men, be appointed to superintend and manage such affairs as concern the public safety and happiness;—that all have their particular provinces assigned them;—that such a subordination be settled among them as none of them may interfere with another; and finally, that certain *rules* or *common measures of action* be agreed on, by which each is to discharge his respective duty to govern or be governed, and all may concur in securing the order, and promoting the felicity, of the whole political body. Those *rules of action* are the *laws* of the community, and those different *orders* are the several officers or magistrates appointed by the public to explain them, and superintend or assist in their execution. In consequence of this settlement of things, it is the duty of each individual to obey the laws enacted, to submit to the executors of them with all due deference and homage, according to their respective ranks and dignity, as to the keepers of the public peace, and the guardians of public liberty; to maintain his own rank, and perform the functions of his own station, with diligence, fidelity, and incorruption. The superiority of the *higher* orders, or the authority with which the state has invested them, intitle them, especially if they employ their authority well, to the obedience and submission of the *lower*, and to a proportionable honour and respect from all. The subordination of the lower ranks claims protection, defence, and security from the higher. And the laws, being superior to all, require the obedience and submission of all, being the last resort, beyond which there is no decision or appeal.

157 Foundation of public spirit, love of liberty, &c.

Public spirit, *heroic zeal*, *love of liberty*, and the other *political* duties, do, above all others, recommend those who practise them to the admiration and homage of mankind; because, as they are the offspring of the noblest minds, so *are they* the parents of the greatest blessing to society. Yet, exalted as they are, it is only in equal and free governments where they can be exercised and have their due effect. For there only does a true *public spirit* prevail, and there only is the *public good* made the standard of the civil constitution. As the end of society is the *common interest* and *welfare* of the people associated, this end must of necessity be the *supreme law* or *common standard*, by which the particular rules of action of the several members of the society towards each other are to be regulated. But a *common interest* can be no other than that which is the result of the *common reason* or *common feelings* of all. Private men, or a particular order of men, have interests and feelings peculiar to themselves, and of which they may be good judges; but these may be separate from, and often contrary to, the interests and feelings of the rest of the society; and therefore they can have no right to make, and much less to impose, laws on their fellow-citizens, inconsistent with, and opposite to, those interests and those feelings. Therefore, a *society*, a *government*, or *real public*, truly worthy the name, and not a confederacy of banditti, a clan of lawless savages, or a band of slaves under the whip of a master, must be such a one as consists of freemen, chusing or consenting to laws themselves; or, since it often happens that they cannot assemble and act in a *collective* body, delegating a sufficient number of *representatives*, *i. e.* such a number as shall most fully comprehend, and most equally represent, their *common feelings* and *common interests*, to digest and vote laws for the conduct and control of the whole body, the most agreeable to those common feelings and common interests.

158 Political duties of every citizen.

A society thus constituted by *common reason*, and formed on the plan of a *common interest*, becomes immediately an object of public attention, public veneration, public obedience, a public and inviolable attachment, which ought neither to be seduced by bribes, nor

nor awed by terrors; an object, in fine, of all thoſe extenſive and important duties which ariſe from ſo glorious a confederacy. To watch over ſuch a ſyſtem; to contribute all he can to promote its good by his reaſon, his ingenuity, his ſtrength, and every other ability, whether natural or acquired; to reſiſt, and, to the utmoſt of his power, defeat every incroachment upon it, whether carried on by a ſecret corruption, or open violence; and to ſacrifice his eaſe, his wealth, his power, nay life itſelf, and, what is dearer ſtill, his family and friends, to defend or ſave it, is the duty, the honour, the intereſt, and the happineſs of every citizen; it will make him venerable and beloved while he lives, be lamented and honoured if he falls in ſo glorious a cauſe, and tranſmit his name with immortal
159, [160] renown to the lateſt poſterity.

Of the people. As the PEOPLE are the fountain of power and authority, the original ſeat of majeſty, the authors of laws, and the creators of officers to execute them; if they ſhall find the power they have conferred abuſed by their truſtees, their majeſty violated by tyranny or by uſurpation, their authority proſtituted to ſupport violence or ſcreen corruption, the laws grown pernicious through accidents unforeſeen or unavoidable, or rendered ineffectual through the infidelity and corruption of the executors of them; then it is their right, and what is their right is their duty, to reſume that delegated power, and call their truſtees to an account; to reſiſt the uſurpation, and extirpate the tyranny; to reſtore their ſullied majeſty and proſtituted authority; to ſuſpend, alter, or abrogate thoſe laws, and puniſh their unfaithful and corrupt officers. Nor is it the duty only of the united body; but every member of it ought, according to his reſpective rank, power, and weight in the community, to concur in advancing and ſupporting thoſe glorious deſigns.

CHAP. IV.

Duty to GOD.

161 Divine connections. OF all the *relations* which the human mind ſuſtains, that which ſubſiſts between the *Creator* and his *creatures*, the ſupreme *Lawgiver* and his *ſubjects*, is the higheſt and the beſt. This relation ariſes from the *nature* of a *creature* in general, and the *conſtitution* of the *human mind* in particular; the nobleſt powers and affections of which point to an *univerſal* mind, and would be imperfect and abortive without ſuch a direction. How lame then muſt that ſyſtem of morals be, which leaves a *Deity* out of the queſtion! How
162 diſconſolate, and how deſtitute of its firmeſt ſupport!

Exiſtence of God. It does not appear, from any true hiſtory, or experience of the mind's progreſs, that any man, by any formal deduction of his diſcurſive power, ever reaſoned himſelf into the belief of a God. Whether ſuch a belief is only ſome *natural anticipation* of ſoul, or is derived from father to ſon, and from one man to another, in the way of *tradition*, or is ſuggeſted to us in conſequence of an *immutable law of our nature*, on beholding the auguſt aſpect and beautiful order of the univerſe, we will not pretend to determine. What ſeems moſt agreeable to experience is, that a *ſenſe* of its *beauty* and *grandeur*, and the *admirable fitneſs* of one thing to another in its vaſt apparatus, leads the mind *neceſſarily* and *unavoidably* to a perception of *deſign*, or of a *deſigning cauſe*, the origin of all, by a progreſs as ſimple and natural as that by which *a beautiful picture*, or a *fine building*, ſuggeſts to us the idea of an *excellent artiſt*. For it ſeems to hold univerſally true, that wherever we diſcern a *tendency*, or *co-operation of things towards a certain end*, or producing a common effect, there, by a neceſſary *law of aſſociation*, we apprehend *deſign*, a *deſigning energy* or *cauſe*. No matter whether the objects are *natural* or *artificial*, ſtill that ſuggeſtion is unavoidable, and the *connection* between the *effect* and its *adequate cauſe* obtrudes itſelf on the mind, and it requires no nice ſearch or elaborate deduction of reaſon, to trace or prove that connection. We are particularly ſatisfied of its truth in the ſubject before us by a kind of direct intuition, and we do not ſeem to attend to the maxim we learn in ſchools, "That there cannot be an *infinite ſeries of* "*cauſes* and *effects* producing and produced by one "another." Nor do we feel a great acceſſion of light and conviction after we have learned it. We are conſcious of our *exiſtence*, of *thought*, *ſentiment*, and *paſſion*, and ſenſible withal that theſe came not of ourſelves; therefore we immediately recogniſe a *parent-mind*, an *original intelligence*, from whom we borrowed thoſe little portions of thought and activity. And while we not only feel *kind* affections in ourſelves, and diſcover them in others, but likewiſe behold round us ſuch a number and variety of creatures, endued with natures nicely adjuſted to their ſeveral ſtations and œconomies, ſupporting and ſupported by each other, and all ſuſtained by a *common order* of things, and ſharing different degrees of happineſs according to their reſpective capacities, we are naturally and neceſſarily led up to the Father of ſuch a numerous offſpring, the fountain of ſuch wide-ſpread happineſs. As we conceive this Being before all, above all, and greater than all, we naturally, and without reaſoning, aſcribe to him every kind of perfection, *wiſdom*, *power*, and *goodneſs without bounds*, exiſting through all 163
time, and pervading all ſpace. We apply to him His relation to the human mind.
thoſe glorious epithets of our *Creator*, *Preſerver*, *Benefactor*, the *ſupreme Lord* and *Lawgiver* of the whole ſociety of rational and intelligent creatures. Not only the imperfections and wants of our being and condition, but ſome of the *nobleſt inſtincts* and *affections* of our minds, connect us with this great and univerſal nature. The mind, in its progreſs from object to object, from one character and proſpect of beauty to another, finds ſome blemiſh or deficiency in each, and ſoon exhauſts, or grows weary and diſſatisfied with its ſubject; it ſees no character of excellency among men equal to that pitch of eſteem which it is capable of exerting; no object within the compaſs of human things adequate to the ſtrength of its affection. Nor can it ſtay any where in this ſelf-expanſive progreſs, or find repoſe after its higheſt flights, till it arrives at a Being of unbounded greatneſs and worth, on whom it may employ its ſublimeſt powers without exhauſting the ſubject, and give ſcope to the utmoſt force and fulneſs of its love without ſatiety or diſguſt. So that the nature of this Being correſponds to the nature of man; nor can his intelligent and moral powers obtain their entire end, but on the ſuppoſition of ſuch a Being, and without a real ſympathy and communication with him.

The native propenſity of the mind to reverence whatever is *great* and *wonderful* in nature, finds a proper object of homage in him who ſpread out the heavens and the earth, and who ſuſtains and governs the whole of things. The *admiration* of *beauty*, the *love* of *order*, and the *complacency* we feel in *goodneſs*, muſt riſe to the higheſt pitch, and attain the full vigour and joy of their operations, when they unite in him who is the ſum and ſource of all perfection.

164 Immorality of impiety. It is evident from the ſlighteſt ſurvey of morals, that how punctual ſoever one may be in performing the duties which reſult from our relations to mankind, yet to be quite deficient in performing thoſe which ariſe from our *relation* to the *Almighty*, muſt argue a ſtrange perverſion of *reaſon* or depravity of *heart*. If imperfect degrees of worth attract our veneration, and if the want of it would imply an inſenſibility, or, which is worſe, an averſion to merit, what lameneſs of affection or immorality of character muſt it be to be unaffected with, and much more to be ill-affected to, a Being of ſuperlative worth! To love ſociety, or particular members of it, and yet to have no ſenſe of our connection with its Head, no affection to our common Parent and Benefactor; to be concerned about the approbation or cenſure of our fellow-creatures, and yet to feel nothing of this kind towards him who ſees and weighs our actions with unerring wiſdom and juſtice, and can fully reward or puniſh them, betrays equal madneſs and partiality of mind. It is plain therefore beyond all doubt, that ſome regards are due to the great Father of all, in whom every lovely and adorable quality combines to inſpire veneration and homage.

165 Right opinions of God. As it has been obſerved already, that our *affections* depend on our *opinions* of their objects, and generally keep pace with them, it muſt be of the higheſt importance, and ſeems to be among the firſt duties we owe to the Author of our being, "to form the leaſt "imperfect, ſince we cannot form perfect, conceptions of his *character* and *adminiſtration*." For ſuch *conceptions*, thoroughly imbibed, will render our *religion* rational, and our *diſpoſitions* refined. If our *opinions* are diminutive and diſtorted, our religion will be ſuperſtitious, and our temper abject. Thus, if we aſcribe to the Deity that falſe majeſty which conſiſts in the unbenevolent and ſullen exerciſe of mere *will* or *power*, or ſuppoſe him to delight in the proſtrations of ſervile fear, or as ſervile praiſe, he will be worſhipped with mean adulation, and a profuſion of compliments. Farther, if he be looked upon as a ſtern and implacable Being, delighting in vengeance, he will be adored with pompous offerings, ſacrifices, or whatever elſe may be thought proper to ſoothe and mollify him. But if we believe *perfect goodneſs* to be the character of the ſupreme Being, and that he loves thoſe moſt who reſemble him moſt, the worſhip paid him will be rational and ſublime, and his worſhippers will ſeek to pleaſe him by imitating that goodneſs which they adore.

166 Rational faith. The foundation then of all true religion is a *rational faith*. And of a rational faith theſe ſeem to be the chief articles, to believe, "that "an infinite all-perfect Mind exiſts, who has no oppoſite nor any ſeparate intereſt from that of his "creatures;—that he ſuperintends and governs all "creatures and things;—that his goodneſs extends to "all his creatures, in different degrees indeed, according to their reſpective natures, but without any "partiality or envy;—that he does every thing for "the beſt, or in a ſubſerviency to the perfection and "happineſs of the whole;—particularly, that he directs and governs the affairs of men,—inſpects their "actions,—diſtinguiſhes the *good* from the *bad*,—loves "and befriends the former,—is diſpleaſed with, and "pities the latter in *this* world,—and will, according "to their reſpective deſerts, reward one and puniſh "the other in the *next*;—that, in fine, he is always "carrying on a ſcheme of virtue and happineſs "through an unlimited duration,—and is ever guiding the univerſe, through its ſucceſſive ſtages and "periods, to higher degrees of perfection and felicity." This is true *Theiſm*, the glorious ſcheme of divine faith; a ſcheme exhibited in all the works of God, and executed through his whole adminiſtration.

167 Morality of theiſm. This faith, well founded and deeply felt, is nearly connected with a *true moral taſte*, and hath a powerful efficacy on the temper and manners of the theiſt. He who admires goodneſs in others, and delights in the practice of it, muſt be conſcious of a reigning order within, a rectitude and candour of heart, which diſpoſes him to entertain favourable apprehenſions of men, and, from an impartial ſurvey of things, to preſume that *good order* and *good meaning* prevail in the univerſe; and if good meaning and good order, then an *ordering*, an *intending mind*, who is no enemy, no tyrant to his creatures, but a *friend*, a *benefactor*, an *indulgent ſovereign*.

168 Immorality of atheiſm. On the other hand, a bad man, having nothing goodly or generous *to contemplate within*, no right intentions, nor honeſty of heart, ſuſpects every perſon and every thing, and, beholding nature through the gloom of a ſelfiſh and guilty mind, is either averſe to the belief of a reigning order, or, if he cannot ſuppreſs the unconquerable anticipations of a governing mind, he is prone to tarniſh the beauty of nature, and to impute malevolence, or blindneſs and impotence at leaſt, to the Sovereign Ruler. He turns the univerſe into a forlorn and horrid waſte, and transfers his own character to the Deity, by aſcribing to him that uncommunicative grandeur, that arbitrary or revengeful ſpirit, which he affects or admires in himſelf. As ſuch a temper of mind naturally leads to *atheiſm*, or to a *ſuperſtition* full as bad; therefore, as far as that temper depends on the unhappy creature in whom it prevails, the propenſity to atheiſm or ſuperſtition conſequent thereto muſt be *immoral*. Farther, if it be true that the belief or ſenſe of a Deity is natural to the mind, and the evidence of his exiſtence reflected from his works ſo full as to ſtrike even the moſt ſuperficial obſerver with conviction, then the ſupplanting or corrupting that ſenſe, or the want of due attention to that evidence, and, in conſequence of both, a *ſupine* ignorance or *affected* unbelief of a Deity, muſt argue a bad temper, or an immoral turn of mind. In the caſe of invincible ignorance, or a very bad education, though nothing can be concluded directly againſt the character; yet whenever ill paſſions and habits pervert the judgment, and by perverting the judgment terminate in atheiſm, then the caſe becomes plainly criminal.

But

169 *The connection of theiſm and virtue.* But let caſuiſts determine this as they will, a true faith in the divine character and adminiſtration is generally the conſequence of a virtuous ſtate of mind. The man who is truly and habitually good feels the *love of order*, of *beauty*, and *goodneſs*, in the ſtrongeſt degree; and therefore cannot be inſenſible to thoſe emanations of them which appear in all the works of God, nor help loving their ſupreme ſource and model. He cannot but think, that he who has poured ſuch beauty and goodneſs over all his works, muſt himſelf delight in beauty and goodneſs, and what he delights in muſt be both amiable and happy. Some indeed there are, and it is pity there ſhould be any ſuch, who, through the unhappy influence of a wrong education, have entertained dark and unfriendly thoughts of a Deity and his adminiſtration, though otherwiſe of a virtuous temper themſelves. However, it muſt be acknowledged, that ſuch ſentiments have, for the moſt part, a bad effect on the temper; and when they have not, it is becauſe the undepraved affections of an honeſt *heart* are more powerful in their operation than the ſpeculative opinions of an informed *head*.

170 *Duties of gratitude, love, &c.* But wherever right conceptions of the Deity and his providence prevail, when he is conſidered as the inexhauſted ſource of light and lov, and joy, as acting in the joint character of a *Father* and *Governor*, imparting an endleſs variety of capacities to his creatures, and ſupplying them with every thing neceſſary to their full completion and happineſs, what veneration and gratitude muſt ſuch conceptions, thoroughly believed, excite in the mind? How natural and delightful muſt it be to one whoſe heart is open to the perception of truth, and of every thing *fair, great*, and *wonderful* in nature, to contemplate and adore him who is the firſt *fair*, the firſt *great*, and firſt *wonderful*; in whom *wiſdom, power*, and *goodneſs* dwell vitally, eſſentially, originally, and act in perfect concert? What *grandeur* is here to fill the moſt enlarged capacity, what *beauty* to engage the moſt ardent love, what a maſs of *wonders* in ſuch exuberance of perfection to aſtoniſh and delight the human mind through an unfailing duration!

171 *Other affections.* If the *Deity* is conſidered as our ſupreme *Guardian* and *Benefactor*, as the *Father of Mercies*, who loves his creatures with infinite tenderneſs, and in a particular manner all good men, nay, all who delight in goodneſs, even in its moſt imperfect degrees; what reſignation, what dependence, what generous confidence, what hope in God and his all-wiſe providence, muſt ariſe in the ſoul that is poſſeſſed of ſuch amiable views of him? All thoſe exerciſes of piety, and above all a ſuperlative eſteem and love, are directed to God as to their *natural*, their *ultimate*, and indeed their only *adequate* object; and though the immenſe obligations we have received from him may excite in us more lively feelings of divine goodneſs than a general and abſtracted contemplation of it, yet the affections of *gratitude* and *love* are of themſelves of the generous diſintereſted kind, not the reſult of ſelf-intereſt, or views of reward. A perfect character, in which we always ſuppoſe infinite goodneſs, guided by unerring wiſdom, and ſupported by Almighty power is the proper object of perfect love; and though that character ſuſtains to us the relation of a *Benefactor*, yet the mind, deeply ſtruck with that perfection, is quite loſt amidſt ſuch a blaze of beauty, and grows as it were inſenſible to thoſe minuter irradiations of it upon itſelf. To talk therefore of a *mercenary* love of God, or which has *fear* for its principal ingredient, is equally impious and abſurd. If we do not love the lovelieſt object in the univerſe for his own ſake, no proſpect of good or fear of ill can ever bribe our eſteem, or captivate our love. Theſe affections are too noble to be bought or ſold, or bartered in the way of *gain*; *worth*, or *merit*, is their object, and their reward is ſomething ſimilar in kind. Whoever indulges ſuch ſentiments and affections towards the Deity, muſt be confirmed in the love of virtue, in a deſire to imitate its all-perfect pattern, and in a chearful ſecurity that all his great concerns, thoſe of his friends, and of the univerſe, ſhall be abſolutely ſafe under the conduct of unerring wiſdom and unbounded goodneſs. It is in his care and providence alone that the good man, who is anxious for the happineſs of all, finds perfect ſerenity, a ſerenity neither ruffled by partial ill, nor ſoured by private diſappointment.

172 *Repentance, &c.* When we conſider the unſtained purity and abſolute perfection of the *divine* nature, and reflect withal on the imperfection and various blemiſhes of our own, we muſt ſink, or be convinced we ought to ſink, into the deepeſt humility and proſtration of ſoul before him, who is ſo wonderfully great and holy. When further, we call to mind what low and languid feelings we have of the divine preſence and majeſty, what inſenſibility of his fatherly and univerſal goodneſs, nay, what ungrateful returns we have made to it, how far we come ſhort of the perfection of his law, and the dignity of our own nature, how much we have indulged to the ſelfiſh paſſions, and how little to the benevolent ones; we muſt be conſcions that it is our duty to repent of a temper and conduct ſo unworthy our nature, and unbecoming our obligations to its Author, and to reſolve and endeavour to act a wiſer and better part for the future.

173 *Hopes of pardon.* Neverthelеſs, from the character which his works exhibit of him, from thoſe delays or alleviations of puniſhment which offenders often experience, and from the merciful tenor of his adminiſtration in many other inſtances, the ſincere penitent may entertain good hopes that his Parent and Judge will not be ſtrict to mark iniquity, but will be propitious and favourable to him, if he honeſtly endeavours to avoid his former practices, and ſubdue his former habits, and to live in a greater conformity to the divine will for the future. If any doubts or fears ſhould ſtill remain, how far it may be conſiſtent with the rectitude and equity of the divine government to let his iniquities paſs unpuniſhed, yet he cannot think it unſuitable to his paternal clemency and wiſdom to contrive a method of retrieving the penitent offender, that ſhall unite and reconcile the majeſty and mercy of his government. If reaſon cannot of itſelf ſuggeſt ſuch a ſcheme, it gives at leaſt ſome ground to expect it. But though *natural religion* cannot let in more light and aſſurance on ſo intereſting a ſubject, yet it will teach the humble theiſt to wait with great ſubmiſſion for any farther intimations it may pleaſe the ſupreme Governor to give of his will; to examine with candour and impartiality whatever

ever evidence ſhall be propoſed to him of a *divine revelation*, whether that evidence is *natural* or *ſupernatural*; to embrace it with veneration and cheerfulneſs, if the evidence is clear and convincing; and finally, if it bring to light any *new relations* or *connections*, *natural religion* will perſuade its ſincere votary faithfully to comply with the *obligations*, and perform the *duties* which reſult from thoſe relations and connections. This is *theiſm*, *piety*, the *completion of morality!*

174 Worſhip, praiſe, thankſgiving. We muſt farther obſerve, that all thoſe affections which we ſuppoſed to regard the Deity as their *immediate* and *primary* object, are vital energies of the ſoul, and conſequently exert themſelves into act, and, like all other energies, gain ſtrength or greater activity by that exertion. It is therefore our *duty* as well as higheſt *intereſt*, often at ſtated times, and by decent and ſolemn acts, to contemplate and adore the great Original of our exiſtence, the Parent of all beauty, and of all good; to expreſs our veneration and love by an awful and devout recognition of his perfections, and to evidence our gratitude by celebrating his goodneſs, and thankfully acknowledging all his benefits. It is likewiſe our duty, by proper exerciſes of ſorrow and humiliation, to confeſs our ingratitude and folly; to ſignify our dependence on God, and our confidence in his goodneſs, by imploring his bleſſing and gracious concurrence in aſſiſting the weakneſs, and curing the corruptions of our nature; and finally, to teſtify our ſenſe of his authority, and our faith in his government, by devoting ourſelves to do his will, and reſigning ourſelves to his diſpoſal. Theſe duties are not therefore obligatory, becauſe the Deity needs not, or can be profited by them; but as they are apparently *decent* and *moral*, ſuitable to the relations he ſuſtains of our *Creator*, *Benefactor*, *Lawgiver*, and *Judge*, expreſſive of our ſtate and obligations; and improving to our tempers, by making us more rational, ſocial, godlike, and conſequently more happy.

175 External worſhip. We have now conſidered INTERNAL piety, or the *worſhip of the mind*, that which is in ſpirit and in truth; we ſhall conclude the ſection with a ſhort account of that which is EXTERNAL. *External* worſhip is founded on the ſame principles as *internal*, and of as ſtrict moral obligation. It is either *private* or *public*. *Devotion* that is *inward*, or *purely intellectual*, is too ſpiritual and abſtracted an operation for the bulk of mankind. The operations of their minds, ſuch eſpecially as are employed on the moſt ſublime, immaterial objects, muſt be aſſiſted by their outward organs, or by ſome help from the imagination; otherwiſe they will ſoon be diſſipated by ſenſible impreſſions, or grow tireſome if too long continued. Ideas are ſuch fleeting things, that they muſt be fixed; and ſo ſubtle, that they muſt be expreſſed and delineated, as it were, by ſenſible marks and images; otherwiſe we cannot attend to them, nor be much affected by them. *Therefore verbal adoration*, *prayer*, *praiſe*, *thankſgiving*, and *confeſſion*, are admirable aids to *inward* devotion, fix our attention, compoſe and enliven our thoughts, impreſs us more deeply with a ſenſe of the awful preſence in which we are, and, by a natural and mechanical ſort of influence, tend to heighten thoſe devout feelings and affections which we ought to entertain, and after this manner reduce into formal and explicit act. 176

This holds true in an higher degree in the caſe of *public* worſhip, where the preſence of our fellow-creatures, and the powerful contagion of the *ſocial* affections, conſpire to kindle and ſpread the devout flame with greater warmth and energy. To conclude: As *God* is the *parent* and *head* of the *ſocial ſyſtem*, as he has formed us for a *ſocial ſtate*, as by *one* we find the beſt ſecurity againſt the ills of life, and in the *other* enjoy its greateſt comforts, and as, by means of *both*, our nature attains its higheſt improvement and perfection; and moreover, as there are *public bleſſings* and *crimes* in which we all ſhare in ſome degree, and *public wants* and *dangers* to which all are expoſed, it is therefore evident, that the various and ſolemn offices of *public religion* are duties of indiſpenſable moral obligation, among the beſt cements of ſociety, the firmeſt prop of government, and the faireſt ornament of both. Public worſhip.

PART III.

CHAP. I.

Of PRACTICAL ETHICS, *or the* CULTURE *of the* MIND.

177 Dignity and importance of the ſubject. WE have now gone through a particular detail of the ſeveral duties we owe to OURSELVES, to SOCIETY, and to GOD. In conſidering the *firſt order* of duties, we juſt touched on the methods of acquiring the different kinds of goods which we are led by nature to purſue; only we left the conſideration of the method of acquiring the *moral* goods of the mind to a chapter by itſelf, becauſe of its ſingular importance. This chapter then will contain a brief enumeration of the arts of acquiring *virtuous habits*, and of eradicating *vicious ones*, as far as is conſiſtent with the brevity of ſuch a work; a ſubject of the utmoſt difficulty as well as importance in morals; to which, nevertheleſs, the leaſt attention has been generally given by *moral* writers. This will properly follow a detail of duty, as it will direct us to ſuch *means* or *helps* as are moſt neceſſary and conducive to the practice of it. 178

In the firſt part of this inquiry we traced the order in which the paſſions ſhoot up in the different periods of human life. That order is not accidental, or dependent on the caprice of men, or the influence of cuſtom and education; but ariſes from the original conſtitution and laws of our nature; of which this is one, *viz.* "That ſenſible objects make the firſt and "ſtrongeſt impreſſions on the mind." Theſe, by means of our outward organs, being conveyed to the mind, become objects of its attention, on which it reflects when the outward objects are no longer preſent, or, in other words, when the impreſſions upon the outward organs ceaſe. Theſe objects of the mind's reflection are called *ideas* or *images*. Towards theſe, by another law of our nature, we are not altogether indifferent; Senſible ideas and ſenſible taſte.

indifferent; but correſpondent movements of *deſire* or *averſion*, *love* or *hatred* ariſe, according as the objects, of which they are images or copies, made an agreeable or diſagreeable impreſſion on our organs. Thoſe *ideas* and *affections* which we experience in the *firſt* period of life, we refer to the *body*, or to *ſenſe*; and the *taſte* which is formed towards them, we call a *ſenſible*, or a merely *natural taſte*; and the objects correſponding to them we in general call *good* or *pleaſant*.

179 Ideas of beauty and a fine taſte.

But as the mind moves forward in its courſe, it extends its views, and receives a new and more *complex* ſet of ideas, in which it obſerves *uniformity*, *variety*, *ſimilitude*, *ſymetry of parts*, *reference to an end*, *novelty*, *grandeur*. Theſe compoſe a vaſt train and diverſity of *imagery*, which the mind compounds, divides, and moulds into a thouſand forms, in the abſence of thoſe objects which firſt introduced it. And this more complicated imagery ſuggeſts a new train of *deſires* and *affections*, full as ſprightly and engaging as any which have yet appeared. This whole claſs of *perceptions* or *impreſſions* is referred to the *imagination*, and forms an higher taſte than the *ſenſible*, and which has an immediate and mighty influence on the *finer* paſſions of our nature, and is commonly termed a *fine taſte*.

The objects which correſpond to this taſte we uſe to call *beautiful*, *great*, *harmonious*, or *wonderful*, or, in general, by the name of *beauty*.

180 Moral ideas and a moral taſte.

The mind, ſtill puſhing onwards and increaſing its ſtock of ideas, aſcends from thoſe to an higher ſpecies of objects, *viz.* the *order* and *mutual relations* of *minds* to each other, their reciprocal *affections*, *characters*, *actions*, and various *aſpects*. In theſe it diſcovers a *beauty*, a *grandeur*, a *decorum*, more intereſting and alluring than in any of the former kinds. Theſe objects, or the images of them paſſing in review before the mind, do, by a neceſſary law of our nature, call forth another and nobler ſet of affections, as *admiration*, *eſteem*, *love*, *honour*, *gratitude*, *benevolence*, and others of the like tribe. This claſs of *perfections*, and their correſpondent *affections*, we refer, becauſe of their objects *(manners)*, to a *moral* ſenſe, and call the *taſte* or *temper* they excite, *moral*. And the objects which are agreeable to this *taſte* or *temper* we denominate by the general name of *moral beauty*, in order to diſtinguiſh it from the other, which is termed *natural*.

181 Sources of aſſociation.

Theſe different ſets of *ideas* or *images* are the materials about which the mind employs itſelf, which it blends, ranges, and diverſifies ten thouſand different ways. It feels a ſtrong propenſion to connect and aſſociate thoſe ideas among which it obſerves any *ſimilitude* or any *aptitude*, whether *original* and *natural*, or *cuſtomary* and *artificial*, to ſuggeſt each other. See METAPHYSICS.

182 Laws of aſſociation.

But whatever the reaſons are, whether *ſimilitude*, *co-exiſtence*, *cauſality*, or any other *aptitude* or *relation*, why any two or more ideas are connected by the mind at firſt, it is an eſtabliſhed law of our nature, "that when two or more ideas have often "ſtarted in company, they form ſo ſtrong an union, "that it is very difficult ever after to ſeparate them." Thus the *lover* cannot ſeparate the idea of *merit* from his *miſtreſs*; the *courtier* that of *dignity* from his *title* or *ribbon*; the *miſer* that of *happineſs* from his *bags*. It is theſe aſſociations of *worth* or *happineſs* with any of the different ſets of *objects* or *images* before ſpecified, that form our *taſte*, or *complex idea* of *good*. By another law of our nature, "our *affections* follow and "are governed by this *taſte*. And to theſe *affections* "our *character* and *conduct* are ſimilar and proportioned, on the general tenor of which our *happineſs* principally depends."

183 Leading paſſions follow taſte.

As all our *leading* paſſions then depend on the direction which our *taſte* takes, and as it is always of the ſame ſtrain with our *leading* aſſociations, it is worth while to enquire a little more particularly how theſe are formed, in order to detect the ſecret ſources from whence our paſſions derive their principal ſtrength, their various riſes and falls. For this will give us the true key to their management, and let us into the right method of correcting the *bad*, and improving the *good*.

184 The impor[illegible]nd uſe of the imagination.

No kind of objects make ſo powerful an impreſſion on us as thoſe which are immediately impreſſed on our *ſenſes*, or ſtrongly painted on our *imaginations*. Whatever is purely *intellectual*, as abſtracted or ſcientific truths, the ſubtle relations and differences of things, has a fainter ſort of exiſtence in the mind; and, though it may exerciſe and whet the *memory*, the *judgment*, or the *reaſoning power*, gives hardly any impulſe at all to the *active* powers, the *paſſions*, which are the main ſprings of motion. On the other hand, were the mind intirely under the direction of *ſenſe*, and impreſſible only by ſuch objects as are preſent, and ſtrike ſome of the outward organs, we ſhould then be preciſely in the ſtate of the brute creation, and be governed ſolely by *inſtinct* or *appetite*, and have no power to controul whatever impreſſions are made upon us: Nature has therefore endued us with a *middle faculty*, wonderfully adapted to our *mixed* ſtate, which holds partly of *ſenſe* and partly of *reaſon*, being ſtrongly allied to the *former*, and the common receptacle in which all the notices that come from that quarter are treaſured up; and yet greatly ſubſervient and miniſterial to the *latter*, by giving a body, a coherence, and beauty to its conceptions. This *middle* faculty is called the *imagination*, one of the moſt buſy and fruitful powers of the mind. Into this common ſtorehouſe are likewiſe carried all thoſe *moral images* or *forms* which are derived from our *moral faculties* of perception; and there they often undergo new changes and appearances, by being mixed and wrought up with the images and forms of *ſenſible* or *natural* things. By this coalition of imagery, *natural beauty* is dignified and heightened by *moral qualities* and *perfections*, and *moral qualities* are at once exhibited and ſet off by *natural beauty*. The *ſenſible* beauty, or good, is refined from its droſs by partaking of the *moral*; and the *moral* receives a ſtamp, a viſible character and currency, from the *ſenſible*.

185 Its energy in various inſtances in heightening ſenſible pleaſures.

As we are firſt of all accuſtomed to *ſenſible* impreſſions and *ſenſible* enjoyments, we contract early a *ſenſual reliſh*, or *love of pleaſure*, in the lower ſenſe of the word. In order however to juſtify this reliſh, the mind, as it becomes open to *higher* perceptions of *beauty* and *good*, borrows from thence a noble ſet of *images*, as *fine taſte*, *generoſity*, *ſocial affections*, *friendſhip*,

ſhip, good fellowſhip, and the like; and, by dreſſing out the old purſuits with theſe new ornaments, gives them an additional dignity and luſtre. By theſe ways the *deſire of a table, love of finery, intrigue*, and *pleaſure*, are vaſtly increaſed beyond their natural pitch, having an impulſe combined of the force of the *natural* appetites, and of the ſuperadded ſtrength of thoſe *paſſions* which tend to the *moral* ſpecies.

186 In heightening the pleaſures of beauty, harmony, &c.

When the mind becomes more ſenſible to thoſe objects or appearances in which it perceives *beauty, uniformity, grandeur*, and *harmony*, as fine cloaths, elegant furniture, plate, pictures, gardens, houſes, equipage, the beauty of animals, and particularly the attractions of the ſex; to theſe objects the mind is led by *nature*, or taught by *cuſtom*, the *opinion* and example of others, to annex certain ideas of *moral character, dignity, decorum, honour, liberality, tenderneſs*, and *active* or *ſocial enjoyment*. The conſequence of this aſſociation is, that the objects to which theſe are annexed muſt riſe in their value, and be purſued with proportionable ardour. The *enjoyment* of them is often attended with *pleaſure*; and the mere *poſſeſſion* of them, where that is wanting, frequently draws reſpect from one's fellow-creatures: This *reſpect* is, by many, thought equivalent to the pleaſure of *enjoyment*. Hence it happens that the idea of *happineſs* is connected with the mere *poſſeſſion*, which is therefore eagerly ſought after, without any regard to the *generous uſe* or *honourable enjoyment*. Thus the paſſion, reſting on the *means*, not the *end*, i. e. loſing ſight of its *natural* object, becomes wild and extravagant.

187 In raiſing the value of external ſymbols, &c.

In fine, any *object*, or *external denomination*, a *ſtaff*, a *garter*, a *cup*, a *crown*, a *title*, may become a *moral* badge or emblem of *merit, magnificence*, or *honour*, according as theſe have been found or thought, by the poſſeſſors or admirers of them, to accompany them; yet, by the deception formerly mentioned, the *merit* or the *conduct* which intitled, or ſhould intitle, to thoſe marks of diſtinction, ſhall be forgot or neglected, and the *badges* themſelves be paſſionately affected or purſued, as including every excellency. If theſe are attained by any means, all the concomitants which *nature, cuſtom*, or *accidents* have joined to them, will be ſuppoſed to follow of courſe. Thus, *moral ends*, with which the unhappy admirer is apt to colour over his paſſion and views, will, in his opinion, juſtify the moſt *immoral means*, as *proſtitution, adulation, fraud, treachery*, and every ſpecies of *knavery*, whether more open or more diſguiſed.

188 In heightening the value of wealth, power, &c.

When men are once engaged in *active* life, and find that *wealth* and *power*, generally called INTEREST, are the great avenues to every kind of enjoyment, they are apt to throw in many engaging *moral forms* to the object of their purſuit, in order to juſtify their paſſion, and varniſh over the meaſures they take to gratify it, as *independency on the vices* or *paſſions* of others, *proviſion* and *ſecurity to themſelves* and *friends, prudent œconomy*, or *well-placed charity, ſocial communication, ſuperiority to their enemies*, who are all villains, *honourable ſervice*, and many other ingredients of *merit*. To attain ſuch capacities of *uſefulneſs* or *enjoyment*, what arts, nay, what meanneſſes, can be thought blameable by thoſe cool purſuers of intereſt?—Nor have they whom the gay world is pleaſed to indulge with the title of *men of pleaſure* their imaginations leſs pregnant with *moral images*, with which they never fail to ennoble, or, if they cannot do that, to palliate their groſs purſuits. Thus *admiration of wit*, of *ſentiments* and *merit, friendſhip, love, generous ſympathy, mutual confidence, giving* and *receiving pleaſure*, are the ordinary ingredients with which they ſeaſon their gallantry and pleaſurable entertainments; and by which they impoſe on themſelves, and endeavour to impoſe on others, that *their amours* are the joint iſſue of good ſenſe and virtue.

189 Its influence on all the paſſions.

Theſe *aſſociations*, variouſly combined and proportioned by the *imagination*, form the chief *private* paſſions, which govern the lives of the generality, as the *love of action*, of *pleaſure, pow r, wealth*, and *fame*; they influence the *defenſive*, and affect the *public paſſions*, and raiſe *joy* or *ſorrow* as they are gratified or diſappointed. So that in effect theſe aſſociations of *good* and *evil, beauty* and *deformity*, and the paſſions they raiſe, are the main *hinges of life* and *manners*, and the great *ſources* of our *happineſs* or *miſery*. It is evident, therefore, that the whole of *moral culture* muſt depend on giving a right direction to the *leading paſſions*, and duly proportioning them to the *value* of the *objects* or *goods* purſued, under what name ſoever they may appear.

190 Moral culture, by correcting our taſte or imagination.

Now, in order to give them this *right direction* and *due proportion*, it appears, from the foregoing detail, that thoſe *aſſociations* of ideas, upon which the paſſions depend, muſt be *duly* regulated; that is to ſay, as an exorbitant paſſion for *wealth, pleaſure*, or *power*, flows from an *aſſociation* or *opinion* that more *beauty* and *good*, whether *natural* or *moral*, enters into the enjoyment or poſſeſſion of them, than really belongs to either; *therefore*, in reſtoring thoſe paſſions to their juſt proportion, we muſt begin with correcting the *opinion*, or breaking the *falſe aſſociation*, or, in other words, we muſt decompound the *complex phantom* of *happineſs* or *good*, which we fondly admire; diſunite thoſe ideas that have no natural alliance; and ſeparate the *original* idea of *wealth, power*, or *pleaſure*, from the foreign mixtures incorporated with it, which enhance its value, or give it its chief power to enchant and ſeduce the mind. For inſtance, let it be conſidered how poor and inconſiderable a thing *wealth* is, if it be disjoined from *real uſe*, or from ideas of *capacity* in the poſſeſſor *to do good*, from *independency, generoſity, proviſion for a family* or *friends*, and *ſocial communication* with others. By this *ſtandard* let its true value be fixed; let its miſapplication, or unbenevolent enjoyment, be accounted ſordid and infamous; and nothing worthy or eſtimable be aſcribed to the *mere poſſeſſion* of it, which is not borrowed from its *generous uſe*.

191 By ſelf-denial, and a counter-proceſs.

If that *complex* form of *good* which is called *pleaſure* engage us, let it be analyſed into its conſtituent principles, or thoſe allurements it draws from the *heart* and *imagination*, in order to heighten the low part of the indulgence; let the *ſeparate* and *comparative* moment of each be diſtinctly aſcertained and deduced from that groſs part, and this remainder of the accumulated enjoyment will dwindle down into a poor, inſipid, tranſitory thing. In proportion as the *opinion* of the *good* purſued abates, the *admiration* muſt decay, and

and the *paſſions* loſe ſtrength of courſe. One effectual way to lower the *opinion*, and conſequently to weaken the habit founded on it, is to practiſe leſſer pieces of ſelf-denial, or to abſtain, to a certain pitch, from the purſuit or enjoyment of the favourite object; and, that this may be the more eaſily accompliſhed, one muſt avoid thoſe occaſions, that company, thoſe places, and the other circumſtances, that enflamed *one* and endeared the *other*. And, as a *counter-proceſs*, let *higher* or even *different* enjoyments be brought in view, other paſſions played upon the former, different places frequented, other exerciſes tried, company kept with perſons of a different or more correct way of thinking, both in *natural* and *moral* ſubjects.

192 By a ſound and natural education.

As much depends on our ſetting out well in life, let the *youthful* fancy, which is apt to be very florid and luxuriant, be early accuſtomed by *inſtruction*, *example*, and ſignificant *moral exerciſes*, nay, by looks, geſtures, and every other teſtimony of juſt approbation or blame, to annex ideas of *merit*, *honour*, and *happineſs*; not to *birth*, *dreſs*, *rank*, *beauty*, *fortune*, *power*, *popularity*, and the like *outward* things, but to *moral* and *truly virtuous qualities*, and to thoſe *enjoyments* which ſpring from a well-informed judgment and a regular conduct of the affections, eſpecially thoſe of the *ſocial* and *diſintereſted* kind. Such dignified forms of *beauty* and *good*, often ſuggeſted, and, by moving pictures and examples, warmly recommended to the *imagination*, enforced by the authority of *conſcience*, and demonſtrated by *reaſon* to be the ſureſt means of enjoyment, and the only independent, undeprivable, and durable goods, will be the beſt counterbalance to meaner paſſions, and the firmeſt foundation and ſecurity to virtue.

193 By rightly ſtudying human nature.

It is of great importance to the forming a *juſt taſte*, or pure and large conceptions of happineſs, to ſtudy and underſtand *human nature* well, to remember what a complicated ſyſtem it is, particularly to have deeply imprinted on our mind that GRADATION of *ſenſes*, *faculties*, and *powers of enjoyment* formerly mentioned, and the *ſub-ordination* of *goods* reſulting from thence, which nature points out, and the experience of mankind confirms; who, when they think ſeriouſly, and are not under the immediate influence of ſome violent prejudice or paſſion, prefer not the pleaſures of *action*, *contemplation*, *ſociety*, and moſt *exerciſes* and *joys* of the *moral* kind, as *friendſhip*, *natural affection*, and the like, to all *ſenſual* gratifications whatſoever? where the different ſpecies of pleaſure are blended into *one complex form*, let them be accurately diſtinguiſhed, and be referred each to its proper *faculty* and *ſenſe*, and examined apart what they have peculiar, what common with others, and what foreign and adventitious.

194 By comparing the moment and abatements of different goods.

Let *wealth*, *grandeur*, *luxury*, *love*, *fame*, and the like, be tried to this teſt, and their true alloy will be found out.—Let it be farther conſidered, whether the mind may not be eaſy and enjoy itſelf greatly, though it want many of thoſe elegancies and ſuperfluities of life which ſome poſſeſs, or that load of wealth and power which others eagerly purſue, and under which they groan. Let the difficulty of attaining, the precariouſneſs of poſſeſſing, and the many abatements in enjoying, overgrown wealth and envied greatneſs, of which the weary poſſeſſors ſo frequently complain, as the hurry of buſineſs, the burden of company, of paying attendance to the *few*, and giving it to the *many*, the cares of keeping, the fears of loſing, and the deſires of increaſing what they have, and the other troubles which accompany this pityful drudgery and pompous ſervitude; let theſe and the like circumſtances be often conſidered, that are conducive to the removing or leſſening the *opinion* of ſuch goods, and the attendant *paſſion* or *ſet of paſſions* will decay of courſe.

195 By obſerving our own bent and character, &c.

Let the peculiar bent of our nature and character be obſerved, whether we are moſt inclined to form aſſociations and reliſh objects of the *ſenſible*, *intellectual*, or *moral* kind. Let that which has the aſcendant be particularly watched, let it be directed to right objects, be improved by proportioned exerciſes, and guarded by proper checks from an oppoſite quarter. Thus the *ſenſible* turn may be exalted by the *intellectual*, and a taſte for the beauty of the *fine arts*, and both may be made ſubſervient to convey and rivet ſentiments highly *moral* and *public-ſpirited*. This inward ſurvey muſt extend to the *ſtrenth* and *weakneſſes* of one's *nature*, one's *conditions*, *connections*, *habitudes*, *fortune*, *ſtudies*, *acquaintance*, and the other circumſtances of one's life, from which every man will form the juſteſt eſtimate of his own diſpoſitions and character, and the beſt rules for correcting and improving them. And in order to do this with more advantage, let thoſe *times* or *critical ſeaſons* be watched when the mind is beſt diſpoſed towards a change; and let them be improved by rigorous *reſolutions*, *promiſes*, or whatever elſe will engage the mind to perſevere in virtue. Let the *conduct*, in fine, be often reviewed, and the *cauſes* of its *corruption* or *improvement* be carefully obſerved.

196 By frequent moral exerciſes.

It will greatly conduce to refine the *moral taſte*, and ſtrengthen the *virtuous temper*, to accuſtom the mind to the frequent exerciſe of *moral ſentiments* and *determinations*, by reading *hiſtory*, *poetry*, particularly of the *pictureſque* and *dramatic* kind, the ſtudy of the *fine arts*; by converſing with the moſt eminent for good ſenſe and virtue; but, above all, by frequent and repeated acts of *humanity*, *compaſſions*, *friendſhip*, *politeneſs*, and *hoſpitality*. It is exerciſe gives health and ſtrength. He that reaſons moſt frequently becomes the wiſeſt, and moſt enjoys the pleaſures of wiſdom. He who is moſt often affected by objects of compaſſions in *poetry*, *hiſtory*, or *real life*, will have his ſoul moſt open to pity, and its delightful pains and duties. So he alſo who practiſes moſt diligently the offices of kindneſs and charity, will by it cultivate that diſpoſition from whence all his pretenſions to perſonal merit muſt ariſe, his preſent and his future happineſs.

197 By an honeſt employment.

An uſeful and honourable employment in life will adminiſter a thouſand opportunities of this kind, and greatly ſtrengthen a ſenſe of virtue and good affections, which muſt be nouriſhed by right training, as well as our underſtandings. For ſuch an employment, by enlarging one's experience, giving an habit of attention and caution, or obliging one, from neceſſity or intereſt, to keep a guard over the paſſions, and ſtudy the outward decencies and appearances of virtue, will by degrees produce good habit, and at length inſinuate

ſinuate the love of virtue and honeſty for its own ſake.

198 By viewing men and manners in a fair light.

It is a great inducement to the exerciſe of benevolence to view *human nature* in a favourable light, to obſerve the characters and circumſtances of mankind on the *faireſt* ſides, to put the beſt conſtructions on their actions they will bear, and to conſider them as the reſult of *partial* and *miſtaken*, rather than *ill* affections, or, at worſt, as the exceſſes of a pardonable ſelf-love, ſeldom or never the effect of pure malice.

199 By conſideration and pious exerciſes.

Above all, the *nature* and *conſequences* of *virtue* and *vice*, their conſequences being the law of our nature and will of heaven; the light in which they appear to our ſupreme *Parent* and *Lawgiver*, and the reception they will meet with from him, muſt be often attended to. The exerciſes of *piety*, as *adoration*, and *praiſe* of the *divine* excellency, *invocation* of and *dependence* on his aid, *confeſſion*, *thankſgiving*, and *reſignation*, are habitually to be indulged, and frequently performed, not only as *medicinal*, but highly *improving* to the temper.

200 By juſt views of human life and its connection with a future.

To conclude: it will be of admirable efficacy towards eradicating *bad* habits, and implanting *good* ones, frequently to contemplate *human life* as the great *nurſery* of our *future* and *immortal exiſtence*, as that *ſtate* of *probation* in which we are to be *educated* for a *divine life*. To remember, that our *virtues* or *vices* will be *immortal* as ourſelves, and influence our *future* as well as our *preſent* happineſs,—and therefore, that every diſpoſition and action is to be regarded as pointing beyond the *preſent* to an *immortal* duration. An habitual attention to this wide and important *connection* will give a vaſt compaſs and dignity to our ſentiments and actions, a noble ſuperiority to the pleaſures and pains of life, and a generous ambition to make our *virtue* as *immortal* as our *being*.

CHAP. II.

Motives to VIRTUE *from Perſonal* HAPPINESS.

201 Motives from perſonal happineſs.

WE have already conſidered our *obligations* to the practice of *virtue*, ariſing from the *conſtitution* of our nature, by which we are led to *approve* a certain *order* and *œconomy* of *affections*, and a certain *courſe of action* correſpondent to it*.—But, beſides this, there are ſeveral motives which ſtrengthen and ſecure virtue, though not themſelves of a *moral* kind. Theſe are, its *tendency to perſonal happineſs*, and the *contrary tendency of vice*. "Perſonal happineſs ariſes "either from the ſtate of a man's own mind, or from "the ſtate and diſpoſition of external cauſes towards "him."

* *Vide*. Part I. chap. i. ii. *&c.*

202 Happineſs of virtue from within.

We ſhall firſt examine the "tendency of virtue to "happineſs with reſpect to the ſtate of a man's own "mind."—This is a point of the utmoſt conſequence in morals, becauſe, unleſs we can convince ourſelves, or ſhew to others, that, by doing our *duty*, or fulfilling our *moral obligations*, we conſult the greateſt ſatisfaction of our own mind, or our higheſt intereſt on the whole, it will raiſe ſtrong and often unſurmountable prejudices againſt the practice of virtue, eſpecially whenever there ariſes any appearances of *oppoſition* between our *duty* and our *ſatisfaction* or *intereſt*. To creatures ſo deſirous of happineſs, and averſe to miſery, as we are, and often ſo odly ſituated amidſt contending paſſions and intereſts, it is neceſſary that virtue appear not only an *honourable*, but a *pleaſing* and *beneficent* form. And in order to juſtify our choice to ourſelves as well as before others, we muſt ourſelves feel and be able to avow in the face of the whole world, that *her* ways are ways of pleaſantneſs, and her paths the paths of peace. This will ſhew, beyond all contradiction, that we not only approve, but can give a ſufficient reaſon for what we do.

203 Influence of vice on the temper of the mind.

Let any man, in a cool hour, when he is diſengaged from buſineſs, and undiſturbed by paſſion (as ſuch cool hours will ſometimes happen) ſit down, and ſeriouſly reflect with himſelf what ſtate or temper of mind he would chuſe to feel and indulge, in order to be eaſy and to enjoy himſelf. Would he chuſe, for that purpoſe, to be in a conſtant diſſipation and hurry of thought; to be diſturbed in the exerciſe of his reaſon; to have various and often interfering phantoms of good playing before his imagination, ſoliciting and diſtracting him by turns, now ſoothing him with amuſing hopes, then torturing him with anxious fears; and to approve this minute what he ſhall condemn the next? Would he chuſe to have a ſtrong and painful ſenſe of every petty injury; quick apprehenſions of every impending evil; inceſſant and inſatiable deſires of power, wealth, honour, pleaſure; an irreconcileable antipathy againſt all competitors and rivals; inſolent and tyrannical diſpoſitions to all below him; fawning, and at the ſame time envious, diſpoſitions to all above him; with dark ſuſpicions and jealouſies of every mortal? Would he chuſe neither to love nor be beloved of any; to have no friend in whom to confide, or with whom to interchange his ſentiments or deſigns; no favourite, on whom to beſtow his kindneſs, or vent his paſſions; in fine, to be conſcious of no merit with mankind, no eſteem from any creature, no good affection to his Maker, no concern for, nor hopes of, his approbation; but, inſtead of all theſe, to hate, and know that he is hated, to condemn, and know that he is condemned by all; by the good, becauſe he is ſo unlike; and by the bad, becauſe he is ſo like themſelves; to hate or to dread the very Being that made him; and, in ſhort, to have his breaſt the ſeat of pride and paſſion, petulance and revenge, deep melancholy, cool malignity, and all the other furies that ever poſſeſſed and tortured mankind?—Would our calm inquirer after happineſs pitch on ſuch a ſtate, and ſuch a temper of mind, as the moſt likely means to put him in poſſeſſion of his deſired eaſe and ſelf-enjoyment?

204 [207.] Influence of virtue on the temper.

Or would he rather chuſe a ſerene and eaſy flow of thought; a reaſon clear and compoſed; a judgment unbiaſſed by prejudice, and undiſtracted by paſſion; a ſober and well-governed fancy, which preſents the images of things true, and unmixed with deluſive and unnatural charms, and therefore adminiſters no improper or dangerous fuel to the paſſions, but leaves the mind free to chuſe or reject, as becomes a reaſonable creature; a ſweet and ſedate temper, not eaſily ruffled by hopes or fears, prone neither to ſuſpicion nor revenge, apt to view men and things in the faireſt lights, and to bend gently to the humours of others rather than obſtinately to contend with them? Would he

he choose such moderation and continence of mind, as neither to be ambitious of *power*, fond of *honours*, covetous of *wealth*, nor a slave to *pleasure*; a mind of course neither elated with success, nor dejected with disappointment; such a modest and noble spirit as supports power without insolence, wears honour without pride, uses wealth without profusion or parsimony; and rejoices more in giving than in receiving pleasure; such fortitude and equanimity as rises above misfortunes, or turns them into blessings; such integrity and greatness of mind, as neither flatters the vices, nor triumphs over the follies of men; as equally spurns servitude and tyranny, and will neither engage in low designs, nor abet them in others? Would he choose, in fine, such mildness and benignity of heart as takes part in all the joys, and refuses none of the sorrows of others; stands well-affected to all mankind; is conscious of meriting the esteem of all, and of being beloved by the best; a mind which delights in doing good without any shew, and yet arrogates nothing on that account; rejoices in loving and being beloved by its Maker, acts ever under his eye, resigns itself to his providence, and triumphs in his approbation?—Which of these dispositions would be his choice, in order to be contented, serene, and happy?—The *former* temper is VICE, the *latter* VIRTUE. Where *one* prevails, there MISERY prevails, and by the generality is acknowledged to prevail. Where the *other* reigns, there HAPPINESS reigns, and by the confession of mankind is acknowledged to reign. The *perfection* of either temper is *misery* or *happiness in perfection*.—THEREFORE, every *approach* to *either extreme* is an *approach* to *misery*, or to *happiness*; *i. e.* every *degree* of *vice* or *virtue* is accompanied with a *proportionable degree* of *misery* or *happiness*.

208 The alleviations of his ills.

The principal alleviations of a virtuous man's calamities are these:—That though some of them may have been the effect of his imprudence or weakness, yet few of them are sharpened by a sense of guilt, and none of them by a consciousness of wickedness, which surely is their keenest sting;—that they are common to him with the best of men;—that they seldom or never attack him quite unprepared, but rather guarded with a consciousness of his own sincerity and virtue, with a faith and trust in providence, and a firm resignation to its perfect orders;—that they may be improved as means of correction, or materials to give scope and stability to his virtues;—and, to name no more, they are considerably lessened, and often sweetened to him, by the general sympathy of the wise and good.

209 His enjoyments.

His enjoyments are more numerous; or, if less numerous, yet more intense than those of the bad man; for he shares in the joys of others by rebound; and every increase of *general* or *particular* happiness is a real addition to his own. It is true, his friendly *sympathy* with others subjects him to some pains which the hard-hearted wretch does not feel; yet to give a loose to it, is a kind of agreeable discharge. It is such a sorrow as he loves to indulge; a sort of pleasing anguish that sweetly melts the mind, and terminates in a self-approving joy. Though the good man may want means to execute, or be disappointed in the success of, his benevolent purposes; yet, as was formerly * observed, he is still conscious of good affection, and that consciousness is an enjoyment of a more delightful favour than the greatest triumphs of successful vice. If the *ambitious*, *covetous*, or *voluptuous*, are disappointed, their passions recoil upon them with a fury proportioned to their opinion of the value of what they pursue, and their hope of success; while they have nothing within to balance the disappointment, unless it is an useless fund of pride, which, however, *frequently* turns mere accidents into mortifying affronts, and exalts grief into rage and frenzy.—Whereas the meek, humble, and benevolent temper is its own reward, is satisfied from within; and, as it magnifies greatly the pleasure of success, so it wonderfully alleviates, and in a manner annihilates, all pain for the want of it.

* See Part II. chap. ii.

210 From merited esteem and sympathy.

As the good man is conscious of loving and wishing well to all mankind, he must be sensible of his deserving the esteem and good-will of all; and this supposed reciprocation of social feelings is, by the very frame of our nature, made a source of very intense and enlivening joys. By this sympathy of affections and interests, he feels himself intimately united with the human race; and, being sensibly *alive* over the whole system, his heart receives and becomes responsive to every touch given to any part. So that, as an eminent *philosopher* § finely expresses it, he gathers contentment and delight from the pleased and happy states of those around him, from accounts and relations of such happiness, from the very countenances, gestures, voices, and sounds even of creatures foreign to our kind, whose signs of joy and contentment he can any way discern.

§ *Vide* Shaftsb. *Inq. into Virtue*, Book II.

211 Do not interfere with other joys.

Nor do those generous affections stop any other natural source of joy whatever, or deaden his sense of any innocent gratification. They rather keep the several *senses* and *powers of enjoyment* open and disengaged, intense and uncorrupted by riot or abuse; as is evident to any one who considers the dissipated, unfeeling state of men of *pleasure*, *ambition*, or *interest*, and compares it with the serene and gentle state of a mind at peace with itself, and friendly to all mankind, unruffled by any violent emotion, and sensible to every good-natured and alluring joy.

212 The misery of excess in the private passions.

It were easy, by going through the different sets of affections mentioned formerly ‡, to shew, that it is only by maintaining the proportion settled there that the mind arrives at true repose and satisfaction. If *fear* exceeds *that* proportion, it sinks into melancholy and dejection. If *anger* passes just bounds, it ferments into rage and revenge, or subsides into a sullen corroding gloom, which embitters every good, and renders one exquisitely sensible to every ill. The *private* passions, the *love of honour* especially, whose impulses are more generous, as its effects are more diffusive, are instruments of private pleasure; but if they are disproportioned to our *wants*, or to the *value* of their several objects, or to the *balance* of other passions equally necessary and more amiable, they become instruments of intense pain and misery. For, being now destitute of that counterpoise which held them at a due pitch, they grow turbulent, peevish, and revengeful, the cause of constant restlessness and torment, sometimes flying out into a wild delirious joy, at other times settling in a deep splenetic grief. The concert between reason and passion is then broke: all is dissonance and distraction within. The mind is out of

‡ See Part I. chap. i. ii.

of frame, and feels an agony proportioned to the violence of the reigning paſſion.

213 In the public affections.
The caſe is much the ſame, or rather worſe, when any of the particular *kind* affections are out of their natural order and proportion; as happens in the caſe of *effeminate pity*, *exorbitant love*, *parental dotage*, or any *party-paſſion*, where the juſt regards to ſociety are ſupplanted. The more *ſocial* and *diſintereſted* the paſſion is, it breaks out into the wilder exceſſes, and makes the more dreadful havoc both within and abroad; as is but too apparent in thoſe caſes where a falſe ſpecies of *religion*, *honour*, *zeal*, or *party-rage*, has ſeized on the natural enthuſiaſm of the mind, and worked it up to madneſs. It breaks through all ties *natural* and *civil*, contracts the moſt ſacred and ſolemn obligations, ſilences every other affection whether *public* or *private*, and transforms the moſt gentle natures into the moſt ſavage and inhuman.

214 Happineſs of well proportioned paſſions.
Whereas the man who keeps the *balance* of *affection* even, is eaſy and ſerene in his motions; mild, and yet affectionate; uniform and conſiſtent with himſelf; is not liable to diſagreeable colliſions of intereſts and paſſions; gives always place to the moſt friendly and humane affections, and never to diſpoſitions or acts of reſentment, but on high occaſions, when the *ſecurity* of the *private*, or *welfare* of the *public* ſyſtem, or the *great intereſts* of mankind, neceſſarily require a noble indignation; and even then he obſerves a juſt meaſure in wrath: and laſt of all, he proportions every paſſion to the value of the object he affects, or to the importance of the end he purſues.

215 Sum of the argument.
To ſum up this part of the argument, the *honeſt* and *good* man has eminently the advantage of the *knaviſh* and *ſelfiſh* wretch in every reſpect. The pleaſures which the *laſt* enjoys flow chiefly from external advantages and gratifications; are ſuperficial and tranſitory; daſhed with long intervals of ſatiety, and frequent returns of remorſe and fear; dependent on favourable accidents and conjunctures; and ſubjected to the humours of men. But the *good* man is ſatisfied from himſelf; his principal poſſeſſions lie within, and therefore beyond the reach of the caprice of men or fortune; his enjoyments are exquiſite and permanent; accompanied with no inward checks to damp them, and always with ideas of dignity and ſelf-approbation; may be taſted at any time, and in any place. The gratifications of *vice* are turbulent and unnatural, generally ariſing from the relief of paſſions in themſelves intolerable, and iſſuing in tormenting reflection; often irritated by diſappointment, always inflamed by enjoyment, and yet ever cloyed with repetition. The pleaſures of *virtue* are calm and natural; flowing from the exerciſe of kind affections, or delightful reflections in conſequence of them; not only agreeable in the proſpect, but in the preſent feeling; they never ſatiate, nor loſe their reliſh; nay, rather the admiration of virtue grows ſtronger every day; and not only is the deſire but the enjoyment heightened by every new gratification; and, unlike to moſt others, it is increaſed, not diminiſhed, by ſympathy and communication.—In fine, the ſatisfactions of *virtue* may be purchaſed without a bribe, and poſſeſſed in the humbleſt as well as the moſt triumphant fortune; they can bear the ſtricteſt review, do not change with circumſtances, nor grow old with time. Force cannot rob, nor fraud cheat us of them; and, to crown all, inſtead of abating, they enhance every other pleaſure.

216 External effects of virtue.
But the happy conſequences of *virtue* are ſeen not only in the internal enjoyments it affords a man, but "in the favourable diſpoſition of external cauſes towards him, to which it contributes."

217 On the body.
As *virtue* gives the ſober poſſeſſion of one's ſelf, and the command of one's paſſions, the conſequence muſt be heart's eaſe, and a fine natural flow of ſpirits, which conduce more than any thing elſe to health and long life. Violent paſſions, and the exceſſes they occaſion, gradually impair and wear down the machine. But the calm placid ſtate of a temperate mind, and the healthful exerciſes in which *virtue* engages her faithful votaries, preſerve the natural functions in full vigour and harmony, and exhilarate the ſpirits, which are the chief inſtruments of action.

218 On one's fortune, intereſt, &c.
It may by ſome be thought odd to aſſert, that *virtue* is no enemy to a man's *fortune* in the preſent ſtate of things.—But if by *fortune* be meant a moderate or competent ſhare of *wealth*, *power*, or *credit*, not overgrown degrees of them; what ſhould hinder the virtuous man from obtaining that? He cannot cringe or fawn, it is true, but he can be civil and obliging as well as the knave; and ſurely his civility is more alluring, becauſe it has more manlineſs and grace in it than the mean adulation of the other: he cannot cheat or undermine; but he may be cautious, provident, watchfull of occaſions, and equally prompt with the rogue in improving them: he ſcorns to proſtitute himſelf as a pander to the paſſions, or as a tool to the vices, of mankind; but he may have as ſound an underſtanding and as good capacities for promoting their real intereſts as the verieſt court-ſlave: and then he is more faithful and true to thoſe who employ him. In the common courſe of buſineſs, he has the ſame chances with the knave of acquiring a fortune, and riſing in the world. He may have equal abilities, equal induſtry, equal attention to buſineſs; and in other reſpects he has greatly the advantage of him. People love better to deal with him; they can truſt him more; they know he will not impoſe on them, nor take advantage of them, and can depend more on his word than on the oath or ſtrongeſt ſecurities of others. Whereas what is commonly called *cunning*, which is the *offſpring* of *ignorance*, and conſtant *companion* of *knavery*, is not only a mean-ſpirited, but a very ſhort-ſighted talent, and a fundamental obſtacle in the road of buſineſs. It may procure indeed immediate and petty gains; but it is attended with dreadful abatements, which do more than overbalance them, both as it ſinks a man's credit when diſcovered, and cramps that largeneſs of mind which extends to the remoteſt as well as the neareſt intereſt, and takes in the moſt durable equally with the moſt tranſient gains. It is therefore eaſy to ſee how much a man's *credit* and *reputation*, and conſequently his ſucceſs, depend on his honeſty and virtue.

219 On one's peace and ſecurity.
With regard to *ſecurity* and *peace* with his neighbours, it may be thought, perhaps, that the man of a quiet forgiving temper, and a flowing benevolence and courteſy, is much expoſed to injury and affronts from every proud or peeviſh mortal, who has the power or will to do miſchief. If we ſuppoſe, indeed this *quietneſs* and *gentleneſs* of nature accompanied with *cowardice*

dice and *puſillanimity*, this may often be the caſe; but in reality the good man is bold as a lion, and ſo much the bolder for being the calmer. Such a perſon will hardly be a butt to mankind. The ill-natured will be afraid to provoke him, and the good-natured will not incline to do it. Beſides, *true virtue*, which is conducted by reaſon, and exerted gracefully and without parade, is a moſt inſinuating and commanding thing; if it cannot diſarm malice and reſentment at once, it will wear them out by degrees, and ſubdue them at length. How many have, by favours and prudently yielding, triumphed over an enemy, who would have been inflamed into tenfold rage by the fierceſt oppoſition! In fine, *goodneſs* is the moſt univerſally popular thing that can be.

220 On one's family. To conclude; the good man may have ſome enemies, but he will have more friends; and, having given ſo many marks of private friendſhip or public virtue, he can hardly be deſtitute of a patron to protect, or a ſanctuary to entertain him, or to protect or entertain his children when he is gone. Though he ſhould have little elſe to leave them, he bequeaths them the faireſt, and generally the moſt unenvied, inheritance of a *good name*, which, like good ſeed ſown in the field of futurity, will often raiſe up unſolicited friends, and yield a benevolent harveſt of unexpected charities. But ſhould the fragrance of the parent's virtue prove offenſive to a perverſe or envious age, or even draw perſecution on the friendleſs orphans, there is *one* in heaven who will be more than a father to them, and recompenſe their parent's virtues by ſhowering down bleſſings on them.

CHAP. III.

Motives to VIRTUE *from the* BEING *and* PROVIDENCE *of* GOD.

221 Two external motives to virtue. BESIDES the intereſting motive mentioned in the laſt *chapter*, there are two great motives to *virtue*, ſtrictly connected with *human life*, and reſulting from the very *conſtitution* of the *human mind*. The firſt is the BEING and PROVIDENCE of GOD; the ſecond is the IMMORTALITY of the SOUL, with *future rewards* and *puniſhments*.

222 Their importance. It appears from Chap iv. of Part II. that *man*, by the *conſtitution* of his nature, is deſigned to be a RELIGIOUS CREATURE. He is intimately connected with the *Deity*, and neceſſarily dependent on him. From that *connection* and neceſſary *dependence* reſult various *obligations* and *duties*, without fulfilling which, ſome of his ſublimeſt powers and affections would be incomplete and abortive. If he be likewiſe an IMMORTAL creature, and if his *preſent conduct* ſhall affect his *future happineſs* in *another* ſtate as well as in the *preſent*; it is evident that we take only a *partial view* of the *creature* if we leave out this important property of his nature, and make a *partial eſtimate of human life*; if we ſtrike out of the account, or overlook, that part of his duration which runs out into eternity.

223 Piety. It is evident from the above-mentioned *chapter*, that "to have a reſpect to the *Deity* in our temper and "conduct, to *venerate* and *love* his *character*, to *adore* "his *goodneſs*, to *depend upon* and *reſign* ourſelves to "his *providence*, to *ſeek* his *approbation*, and *act* un-"der a *ſenſe* of his *authority*, is a *fundamental part* of "*moral virtue*, and the *completion* of the *higheſt de-"ſtination* of *our nature*."

But as *piety* is an eſſential part of virtue, ſo likewiſe it is a *great ſupport* and *enforcement* to the practice of it. To contemplate and admire a Being of ſuch tranſcendent dignity and perfection as GOD, muſt naturally and neceſſarily open and enlarge the mind, give a freedom and ampleneſs to its powers, and a grandeur and elevation to its aims. For, as an excellent *divine* obſerves, "the greatneſs of an object, and the ex-"cellency of the act of any AGENT about a tran-"ſcendent object, doth mightily tend to the enlarge-"ment and improvement of his faculties." Little objects, mean company, mean cares, and mean buſineſs, cramp the mind, contract its views, and give it a creeping air and deportment. But when it ſoars above mortal cares and mortal purſuits into the regions of divinity, and converſes with the greateſt and beſt of Beings, it ſpreads itſelf into a wider compaſs, takes higher flights in reaſon and goodneſs, becomes godlike in its air and manners. *Virtue* is, if one may ſay ſo, both the *effect* and *cauſe* of largeneſs of mind. It requires that one think freely, and act nobly. Now what can conduce more to freedom of thought and dignity of action, than to conceive worthily of GOD, to reverence and adore his unrivalled excellency, to imitate and tranſcribe that excellency into our own nature, to remember our relation to him, and that we are the image and repreſentatives of his glory to the reſt of the creation? Such feelings and exerciſes muſt and will make us ſcorn all actions that are baſe, unhandſome, or unworthy our ſtate; and the relation we ſtand in to GOD will irradiate the mind with the light of wiſdom, and ennoble it with the liberty and dominion of virtue. 224 A ſupport to virtue.

The influence and efficacy of *religion* may be conſidered in another light. We all know that the preſence of a friend, a neighbour, or any number of ſpectators, but eſpecially an auguſt aſſembly of them, uſes to be a conſiderable check upon the conduct of one who is not loſt to all ſenſe of honour and ſhame, and contributes to reſtrain many irregular ſallies of paſſion. In the ſame manner we may imagine, that the awe of ſome ſuperior mind, who is ſuppoſed privy to our ſecret conduct, and armed with full power to reward or puniſh it, will impoſe a reſtraint on us in ſuch actions as fall not under the controul or animadverſion of others. If we go ſtill higher, and ſuppoſe our inmoſt thoughts and darkeſt deſigns, as well as our moſt ſecret actions, to lie open to the notice of the ſupreme and univerſal mind, who is both the *ſpectator* and *judge* of human actions, it is evident that the belief of ſo auguſt a preſence, and ſuch awful inſpection, muſt carry a reſtraint and weight with it proportioned to the ſtrengh of that belief, and be an additional motive to the practice of many duties which would not have been performed without it. 225 A guard and enforcement to virtue.

It may be obſerved farther, that "to live under "an habitual ſenſe of the *Deity* and his great *admi-"niſtration*, is to be converſant with *wiſdom*, *order*, "and *beauty*, in the higheſt ſubjects, and to receive "the delightful reflections and benign feelings which "theſe excite while they irradiate upon him from every "ſcene of nature and providence." How improving muſt ſuch views be to the mind, in dilating and exalt- 226 Exerciſes of piety improving to virtue.

ing it above thoſe puny intereſts and competitions which agitate and inflame the bulk of mankind againſt each other!

Chap. IV.

Motive to Virtue *from the Immortality of the* Soul, *&c.*

217 Metaphyſical arguments for its immortality.

The other motive mentioned was the *immortality* of the ſoul, with *future rewards* and *puniſhments*. The *metaphyſical* proofs of the ſoul's immortality are commonly drawn from—its *ſimple*, *uncompounded*, and *indiviſible* nature; from whence it is concluded, that it cannot be corrupted or extinguiſhed by a diſſolution or deſtruction of its parts:—from its having a *beginning* of *motion* within itſelf; whence it is inferred, that it cannot diſcontinue and loſe its motion:—from the different properties of *matter* and *mind*, the *ſluggiſhneſs* and *inactivity of one*, and the immenſe *activity* of the *other;* its prodigious flight of *thought* and *imagination;* its *penetration*, *memory*, *foreſight*, and *anticipations* of *futurity:* from whence it is concluded, that a being of ſo divine a nature cannot be extinguiſhed. But as theſe metaphyſical proofs depend on intricate reaſonings concerning the *nature*, *properties*, and *diſtinctions* of *body* and *mind*, with which we are not very well acquainted, they are not obvious to ordinary underſtandings, and are ſeldom ſo convincing even to thoſe of higher reach, as not to leave ſome doubts behind them. Therefore perhaps it is not ſo ſafe to reſt the proof of ſuch an important article on what many may call the ſubtilties of ſchool-learning. Thoſe proofs which are brought from *analogy*, from the *moral conſtitution* and *phænomena* of the *human mind*, the *moral attributes* of God, and the *preſent courſe of things*, and which therefore are called the *moral* arguments, are the plaineſt, and generally the moſt ſatisfying. We ſhall ſelect only one or two from the reſt.

218 Moral proof from analogy.

In tracing the *nature* and *deſtination* of any being, we form the ſureſt judgment from his *powers* of *action*, and the ſcope and *limits* of theſe, compared with his *ſtate*, or with that *field* in which they are exerciſed. If this being paſſes through different ſtates, or fields of action, and we find a *ſucceſſion* of powers adapted to the different periods of his progreſs, we conclude that he was deſtined for thoſe ſucceſſive ſtates, and reckon his nature *progreſſive*. If, beſides the immediate ſet of powers which fit him for action in his preſent ſtate, we obſerve another ſet which appear ſuperfluous if he were to be confined to it, and which point to another or higher one, we naturally conclude, that he is not deſigned to remain in his preſent ſtate, but to advance to that for which thoſe ſupernumerary powers are adapted. Thus we argue, that the *inſect*, which has wings forming or formed, and all the apparatus proper for flight, is not deſtined always to creep on the ground, or to continue in the torpid ſtate of adhering to a wall, but is deſigned in its ſeaſon to take its flight in air. Without this farther deſtination, the admirable mechaniſm of wings and the other apparatus would be uſeleſs and abſurd. The ſame kind of reaſoning may be applied to man, while he lives only a ſort of *vegetative* life in the womb. He is furniſhed even there with a beautiful apparatus of organs, eyes, ears, and other delicate ſenſes, which receive nouriſhment indeed, but are in a manner folded up, and have no proper exerciſe or uſe in their preſent confinement *. Let us ſuppoſe ſome intelligent ſpectator, who never had any connection with man, nor the leaſt acquaintance with human affairs, to ſee this odd phenomenon, a creature formed after ſuch a manner, and placed in a ſituation apparently unſuitable to ſuch various machinery: muſt he not be ſtrangely puzzled about the uſe of his complicated ſtructure, and reckon ſuch a profuſion of art and admirable workmanſhip loſt on the ſubject; or reaſon by way of anticipation, that a creature endued with ſuch various yet unexerted capacities, was deſtined for a more enlarged ſphere of action, in which thoſe latent capacities ſhall have full play? The vaſt variety and yet beautiful ſymmetry and proportions of the ſeveral parts and organs with which the creature is endued, and their apt coheſion with and dependence on the curious receptacle of their life and nouriſhment, would forbid his concluding the whole to be the birth of chance, or the bungling effort of an unſkilful artiſt; at leaſt would make him demur a while at ſo harſh a ſentence. But if, while he is in this ſtate of uncertainty, we ſuppoſe him to ſee the babe, after a few ſucceſsful ſtruggles, throwing off his fetters, breaking looſe from his little dark priſon, and emerging into open day, then unfolding his recluſe and dormant powers, breathing in air, gazing at light, admitting colours, ſounds, and all the *fair variety* of nature; immediately his doubts clear up, the propriety and excellency of the workmanſhip dawn upon him with full luſtre, and the whole myſtery of the firſt period is unravelled by the opening of this new ſcene. Though in this *ſecond* period the creature lives chiefly a kind of *animal*-life, i. e. of *ſenſe* and *appetite*, yet by various trials and obſervations he gains experience, and by the gradual evolution of the powers of *imagination* he ripens apace for an *higher* life, for exerciſing the arts of *deſign* and *imitation*, and of thoſe in which ſtrength or dexterity are more requiſite than acuteneſs or reach of judgment. In the ſucceeding *rational* or *intellectual* period, his *underſtanding*, which formerly crept in a lower, mounts into an higher ſphere, canvaſſes the natures, judges of the relations of things, forms ſchemes, deduces conſequences from what is paſt, and from preſent as well as paſt collects future events. By this ſucceſſion of ſtates, and of correſpondent culture, he grows up at length into a *moral*, a *ſocial*, and a *political* creature. This is the laſt period at which we perceive him to arrive in this his mortal career. Each *period* is introductory to the next ſucceeding one; each *life* is a field of exerciſe and improvement for the next higher one; the life of the *fœtus* for that of the *infant*, the life of the *infant* for that of the *child*, and all the lower for the higheſt and beſt *.—But is this the laſt period of nature's progreſſion? Is this the utmoſt extent of her plot, where ſhe winds up the drama, and diſmiſſes the actor into eternal oblivion? Or does he appear to be inveſted with ſupernumerary powers, which have not full exerciſe and ſcope even in the laſt ſcene, and reach not that maturity or perfection of which they are capable; and therefore point to ſome higher ſcene where he is to ſuſtain another and more important character than he has yet ſuſtained? If any ſuch there are, may we not conclude by analogy, or in the ſame way of anticipation

* *Vide* Ludov. Viv. *de Relig. Chriſt.* Lib. II. *de Vita Uteri, &c.*

* *See* Butler's *Analogy*, Part I.

tion as before, that he is deftined for that after-part, and is to be produced upon a more auguft and folemn ftage, where his fublimer powers fhall have proportioned action, and its nature attain its completion?

229 Powers in man which point to an after-life. If we attend to that *curiofity*, or prodigious *thirft* of *knowledge*, which is natural to the mind in every period of its progrefs, and confider withal the endlefs round of bufinefs and care, and the various hardfhips to

230 Intellectual. which the bulk of mankind are chained down; it is evident, that in this prefent ftate it is impoffible to expect the gratification of an appetite at once fo infatiable and fo noble. Our *fenfes*, the ordinary organs by which knowledge is let into the mind, are always imperfect, and often fallacious; the advantages of affifting or correcting them are poffeffed by few; the difficulties of finding out truth amidft the various and contradictory opinions, interefts, and paffions of mankind, are many; and the wants of the creature, and of thofe with whom he is connected, numerous and urgent: fo that it may be faid of moft men, that their *intellectual* organs are as much fhut up and fecluded from proper nourifhment and exercife in that little circle to which they are confined, as the bodily organs are in the womb. Nay, thofe who to an afpiring genius have added all the affiftances of art, leifure, and the moft liberal education, what narrow profpects can even they take of this unbounded fcene of things from that little eminence on which they ftand? and how eagerly do they ftill grafp at new difcoveries, without any fatisfaction or limit to their ambition?

231 Moral powers. But fhould it be faid, that man is made for *action*, and not for *fpeculation*, or fruitlefs fearches after knowledge, we afk, For what kind of action? Is it only for bodily exercifes, or for *moral*, *political*, and *religious* ones? Of all thefe he is capable; yet, by the unavoidable circumftances of his lot, he is tied down to the *former*, and has hardly any leifure to think of the *latter*, or, if he has, wants the proper inftruments of exerting them. The *love of virtue*, *of one's friends* and *country*, the *generous fympathy with mankind*, and *heroic zeal of doing good*, which are all fo *natural* to great and good minds, and fome traces of which are found in the loweft, are feldom united with proportioned means or opportunities of exercifing them: fo that the *moral* fpring, the noble energies and impulfes of the mind, can hardly find proper fcope even in the moft fortunate condition; but are much depreffed in fome, and almoft entirely reftrained in the generality, by the numerous clogs of an indigent, fickly, or embarraffed life. Were fuch mighty powers, fuch godlike affections, planted in the human breaft to be folded up in the narrow womb of our prefent exiftence, never to be produced into a more *perfect* life, nor to expatiate in the ample career of immortality?

232 Unfatisfied defires of exiftence and happinefs. Let it be confidered, at the fame time, that no poffeffion, no enjoyment within the round of mortal things, is commenfurate to the defires, or adequate to the capacities, of the mind. The moft exalted condition has its abatements; the happieft conjuncture of fortune leaves many wifhes behind; and, after the higheft gratifications, the mind is carried forward in purfuit of new ones without end. Add to all, the fond *defire* of *immortality*, the fecret *dread* of *nonexiftence*, and the high unremitting *pulfe* of the foul beating for *perfection*, joined to the improbability or the impoffibility of attaining it *here*; and then judge whether this elaborate ftructure, this magnificent apparatus of inward powers and organs, does not plainly point out an *hereafter*, *and intimate eternity to man*? Does nature give the finifhing touches to the leffer and ignobler inftances of her fkill, and raife every other creature to the maturity and perfection of his being; and fhall fhe leave her principal workmanfhip unfinifhed? Does fhe carry the *vegetative* and *animal* life in *man* to their full vigour and higheft deftination; and fhall fhe fuffer his *intellectual*, his *moral*, his *divine* life to fade away, and be for ever extinguifhed? Would fuch abortions in the *moral* world be congruous to that *perfection of wifdom and goodnefs* which upholds and adorns the *natural*?

We muft therefore conclude from this detail, that the *prefent ftate*, even at its beft, is only the WOMB of man's being, in which the nobleft principles of his nature are in a manner fettered, or fecluded from a correfpondent fphere of action; and therefore deftined for a future and unbounded ftate, where they fhall emancipate themfelves, and exert the fulnefs of their ftrength. The moft accomplifhed mortal, in this low and dark apartment of nature, is only the *rudiments* of what he fhall be when he takes his ethereal flight, and puts on immortality. Without a reference to that ftate, *man* were a mere abortion, a rude unfinifhed embryo, a monfter in nature. But this being once fuppofed, he ftill maintains his rank of the mafterpiece of the creation; his latent powers are all fuitable to the *harmony* and *progreffion* of nature; his noble afpirations, and the pains of his diffolution, are his efforts towards a *fecond* birth, the pangs of his delivery into light, liberty, and perfection; and *death*, his difcharge from goal, his feparation from his fellow-prifoners, and introduction into the affembly of thofe heroic fpirits who are gone before him, and of their great eternal Parent. The fetters of his mortal coil being loofened, and his prifon-walls broke down, he will be bare and open on every fide to the admiffion of *truth* and *virtue*, and their fair attendant *happinefs*; every *vital* and *intellectual* fpring will evolve itfelf with a divine elafticity in the free air of heaven. He will not then peep at the univerfe and its glorious Author through a dark grate or a grofs medium, nor receive the reflections of his glory through the ftrait openings of fenfible organs; but will be *all eye*, *all ear*, *all ethereal and divine feeling* *. Let one part, however, of the analogy be attended to: That as in the womb we receive our original conftitution, form, and the effential *ftamina* of our being, which we carry along with us into the light, and which greatly affect the fucceeding periods of our life; fo our temper and condition in the *future* life will depend on the conduct we have obferved, and the character we have formed, in the *prefent* life. We are *here* in *miniature* what we fhall be at *full length hereafter*. The firft *rude fketch* or *out-lines* of *reafon* and *virtue* muft be drawn at prefent, to be afterwards enlarged to the *ftature* and *beauty* of angels.

233 Therefore man immortal.

* *Vide* Religion of Nature, § 9.

This, if duly attended to, muft prove not only a *guard*, but an admirable *incentive* to virtue. For he who faithfully and ardently follows the lights of knowledge, and pants after higher improvements in virtue, 234 Immortality a guard and incentive to virtue.

will

will be wonderfully animated and inflamed in that purſuit by a full conviction that the ſcene does not cloſe with life—that his ſtruggles, ariſing from the weakneſs of nature and the ſtrength of habit, will be turned into triumphs—that his career in the tract of wiſdom and goodneſs will be both ſwifter and ſmoother—and thoſe generous ardours with which he glows towards *heaven*, *i. e.* the *perfection* and *immortality of virtue*, will find their adequate object and exerciſe in a ſphere proportionably enlarged, incorruptible, immortal. On the other hand, what an inexpreſſible damp muſt it be to the good man, to dread the total extinction of that *light* and *virtue*, without which *life*, nay, *immortality* itſelf, were not worth a ſingle wiſh?

235 Proof from the inequality of preſent diſtributions.

Many writers draw their proofs of the immortality of the ſoul, and of a future ſtate of rewards and puniſhments, from the unequal diſtribution of theſe here. It cannot be diſſembled that wicked men often eſcape the *outward* puniſhment due to their crimes, and do not feel the *inward* in that meaſure their demerit ſeems to require, partly from the callouſneſs induced upon their nature by the habits of vice, and partly from the diſſipation of their minds abroad by pleaſure or buſineſs—and ſometimes good men do not reap all the natural and genuine fruits of their virtue, through the many unforeſeen or unavoidable calamities in which they are involved. This, no doubt, upon the ſuppoſition of an all-wiſe and good Providence, were an argument, and a ſtrong one too, for a future ſtate, in which thoſe inequalities ſhall be corrected. But unleſs we ſuppoſe a *prepollent good order* in the preſent ſcene of things, we weaken the proof of the *divine* adminiſtration, and the preſumption of any better order in any future period of it.

236 Belief of immortality, &c. a great ſupport amidſt trials.

Virtue has preſent rewards, and *vice* preſent puniſhments, annexed to it; ſuch rewards and puniſhments as make *virtue*, in moſt caſes that happen, far more eligible than *vice:* but, in the infinite variety of human contingencies, it may ſometimes fall out, that the inflexible practice of virtue ſhall deprive a man of conſiderable advantages to himſelf, his family, or friends, which he might gain by a well-timed piece of roguery; ſuppoſe by betraying his truſt, voting againſt his conſcience, ſelling his country, or any other crime, where the ſecurity againſt diſcovery ſhall heighten the temptation. Or, it may happen, that a ſtrict adherence to his honour, to his religion, to the cauſe of liberty and virtue, ſhall expoſe him, or his family, to the loſs of every thing, nay, to poverty, ſlavery, death itſelf, or to torments far more intolerable. Now what ſhall ſecure a man's virtue in circumſtances of ſuch trial? What ſhall enforce the obligations of conſcience againſt the allurements of ſo many intereſts, the dread of ſo many and ſo terrible evils, and the almoſt unſurmountable averſion of human nature to exceſſive pain! The conflict is the greater, when the circumſtances of the crime are ſuch as eaſily admit a variety of alleviations from *neceſſity*, *natural affection*, *love to one's family* or *friends*, perhaps in indigence: theſe will give it even the air of virtue. Add to all, that the crime may be thought to have few bad conſequences,—may be eaſily concealed,—or imagined poſſible to be retrieved in a good meaſure by future good conduct. It is obvious to which ſide moſt men will lean in ſuch a caſe; and how much need there is of a balance in the oppoſite ſcale, from the conſideration of a *God*, of a *Providence*, and of an *immortal ſtate* of *retribution*, to keep the mind firm and uncorrupt in thoſe or like inſtances of ſingular trial or diſtreſs.

237 In the general courſe of life.

But without ſuppoſing ſuch peculiar inſtances, a ſenſe of a governing Mind, and a perſuaſion that virtue is not only befriended by him here, but will be crowned by him hereafter with rewards ſuitable to its nature, vaſt in themſelves, and immortal in their duration, muſt be not only a mighty ſupport and incentive to the practice of virtue, but a ſtrong barrier againſt vice. The thoughts of an Almighty Judge, and of an impartial future reckoning, are often alarming, inexpreſſibly ſo, even to the ſtouteſt offenders. On the other hand, how ſupporting muſt it be to the good man, to think that he acts under the eye of his friend, as well as judge! How improving, to conſider the *preſent ſtate* as connected with a *future* one, and every relation in which he ſtands as a *ſchool* of *diſcipline* for his *affections;* every *trial* as the *exerciſe* of ſome *virtue;* and the virtuous deeds which reſult from both, as introductory to higher ſcenes of *action* and *enjoyment!* Finally, how tranſporting is it to view *death* as his *diſcharge* from the *warfare* of *mortality*, and a triumphant *entry* into a ſtate of freedom, ſecurity, and perfection, in which knowledge and wiſdom ſhall break upon him from every quarter; where each faculty ſhall have its proper object; and his virtue, which was often damped or defeated here, ſhall be enthroned in undiſturbed and eternal empire!

238 Advantages of the Chriſtian ſcheme, and its connection with natural religion or morality.

On reviewing this ſhort *ſyſtem* of *morals*, and the *motives* which ſupport and enforce it, and comparing both with the Christian *ſcheme*, what *light* and *vigour* do they borrow from thence! How clearly and fully does Christianity lay open the *connections* of our nature, both *material* and *immaterial*, and *future* as well as *preſent!* What an ample and beautiful detail does it preſent of the *duties* we owe to *God*, to *ſociety*, and *ourſelves*, promulgated in the moſt ſimple, intelligible, and popular manner; diveſted of every partiality of ſect or nation; and adapted to the general ſtate of mankind! With what bright and alluring *examples* does it illuſtrate and recommend the practice of thoſe duties; and with what mighty *ſanctions* does it enforce that practice! How ſtrongly does it deſcribe the *corruptions* of our nature; the *deviations* of our life from the *rule* of *duty*, and the *cauſes* of both! How marvellous and benevolent a plan of *redemption* does it unfold, by which thoſe corruptions may be remedied, and our *nature* reſtored from its *deviations* to tranſcendent heights of *virtue* and *piety!* Finally, what a fair and comprehenſive proſpect does it give us of the *adminiſtration* of *God*, of which it repreſents the *preſent ſtate* only as a *ſmall period*, and a *period* of *warfare* and *trial!* How ſolemn and unbounded are the ſcenes which it opens beyond it! the *reſurrection* of the *dead*, the *general judgment*, the *equal diſtribution* of *rewards* and *puniſhments* to the *good* and the *bad;* and the full *completion* of *divine wiſdom* and *goodneſs* in the *final eſtabliſhment* of *order*, *perfection*, and *happineſs!* How glorious then is that Scheme of Religion, and how worthy of *affection* as well as of *admiration*, which, by making ſuch *diſcoveries*, and affording ſuch *aſſiſtances*, has diſcloſed the unfading fruits and triumphs of virtue, and ſecured its intereſts beyond the power of time and chance!

MORAL *Sense*, that whereby we perceive what is good, virtuous, and beautiful, in actions, manners, and characters. See MORAL *Philosophy*.

MORALITY. See MORAL *Philosophy*.

MORASS, a low and moist land, which receives the waters from the higher grounds without having any descent to carry them off.

MORATA (Olympia Fulvia), an Italian lady, distinguished for her learning, was born at Ferrara, in 1526. Her father, after teaching the belles lettres in several cities of Italy, was made preceptor to the two young princes of Ferrara, the sons of Alphonsus I. The uncommon abilities he discovered in his daughter determined him to give her a very extraordinary education. Meanwhile the princess of Ferrara studying polite literature, it was judged expedient that she should have a companion in the same pursuit; and Morata being called, she was heard by the astonished courtiers to declaim in Latin, to speak Greek, and to explain the paradoxes of Cicero. Her father dying, she was obliged to return home, to take upon her the management of family-affairs, and the education of her brother and three sisters; both which she executed with the greatest diligence and success. In the mean time Andrew Grunthler, a young German, who had studied physic, and taken his doctor's degree at Ferrara, fell in love with her, and married her. She now went with her husband to Germany, taking her little brother with her, whom she instructed in the Latin and Greek tongues; and after staying a short time at Augsburg, went to Schweinfort in Franconia, where her husband was born: but they had not been there long before that town was unhappily besieged and burnt; however, escaping the flames, they fled in the utmost distress to Hammelburg. This place they were also obliged to quit, and were reduced to the last extremities, when the elector palatine invited Grunthler to be professor of physic at Heidelberg, and he entered on his new office in 1554; but they no sooner began to taste the sweets of repose, than a disease, occasioned by the distresses and hardships they had suffered, seized upon Morata, who died in 1555, in the 29th year of her age; and her husband and brother did not long survive her. She composed several works, great part of which were burnt with the town of Schweinfort; the remainder, which consist of orations, dialogues, letters, and translations, were collected and published under the title of *Olympiæ Fulviæ Moratæ, fœminæ doctissimæ, et plane divinæ, opera omnia quæ hactenus invenire potuerint; quibus Cœlii secundi curionis epistolæ ac orationes accesserunt;* which has had several editions in octavo.

MORAVIA, a marquisate of Germany, derives the name of *Mahern*, as it is called by the Germans, and of *Morawa*, as it is called by the natives, from the river of that name which rises in the mountains of the county of Glatz, and passes through the middle of it. It is bounded to the south by Austria, to the north by Glatz and Silesia, to the west by Bohemia, and to the east by Silesia and Hungary; being about 120 miles in length, and 100 in breadth.

A great part of this country is over-run with woods and mountains, where the air is very cold, but much wholesomer than in the low grounds, which are full of bogs and lakes. The mountains, in general, are barren; but the more champaign parts tolerably fertile, yielding corn, with plenty of hemp and flax, good saffron, and pasture. Nor is it altogether destitute of wine, red and white, fruits, and garden-stuff. Moravia also abounds in horses, black cattle, sheep, and goats. In the woods and about the lakes there is plenty of wild fowl, game, venison, bees, honey, hares, foxes, wolves, beavers, &c. In this country are likewise quarries of marble, bastard diamonds, amethysts, alum, iron, sulphur, salt-petre, and vitriol, with wholesome mineral-waters, and warm springs; but salt is imported. Its rivers, of which the March, Morawa, or Morau, are the chief, abound with trout, crayfish, barbels, eels, perch, and many other sorts of fish.

The language of the inhabitants is a dialect of the Sclavonic, differing little from the Bohemian; but the nobility and citizens speak German and French.

Moravia was anciently inhabited by the Quadi, who were driven out by the Sclavi. Its kings, who were once powerful and independent, afterwards became dependent on, and tributary to, the German emperors and kings. At last, in the year 908, the Moravian kingdom was parcelled out among the Germans, Poles, and Hungarians. In 1086, that part of it properly called *Moravia* was declared a marquisate by the German king Henry IV. and united with Bohemia, to whose dukes and kings it hath ever since been subject. Though it is not very populous, it contains about 42 greater or walled towns, 17 smaller or open towns, and 198 market-towns, besides villages, &c. The states of the country consist of the clergy, lords, knights, and burgesses; and the diets, when summoned by the regency, are held at Brunn. The marquisate is still governed by its own peculiar constitutions, under the *directorium in publicis & cameralibus*, and the supreme judicatory at Vienna. It is divided into six circles, each of which has its captain, and contributes to its sovereign about one-third of what is exacted of Bohemia. Towards the expences of the military establishment of the whole Austrian hereditary countries, its yearly quota is 1,856,490 florins. Seven regiments of foot, one of cuirassiers, and one of dragoons, are usually quartered in it.

Christianity was planted in this country in the 9th century; and the inhabitants continued attached to the church of Rome till the 15th, when they espoused the doctrine of John Huss, and threw off popery: but after the defeat of the elector Palatine, whom they had chosen king, as well as the Bohemians, the emperor Ferdinand II. re-established popery. However, there are still some Protestants in Moravia; and here it was that the *Hernhutters*, or *Moravian Brethren*, first made their appearance. See MORAVIANS. The bishop of Olmutz, who stands immediately under the pope, is at the head of the ecclesiastics in this country. The supreme ecclesiastical jurisdiction, under the bishop, is vested in a consistory.

The commerce of this country is inconsiderable. Of what they have, Brunn enjoys the principal part. At Iglau and Trebitx are manufactures of cloth, paper, gun-powder, &c. There are also some iron-works and glass-houses in the country.

The inhabitants of Moravia in general are open-hearted, not easy to be provoked or pacified, obedient to their masters, and true to their promises; but credu-

lous.

lous of old prophecies, and much addicted to drinking, though neither fuch fots or bigots as they are reprefented by fome geographers. The boors, indeed, upon the river Hanak, are faid to be a thievifh, unpolifhed, brutal race. The fciences now begin to lift up their heads a little among the Moravians, the univerfity of Olmutz having been put on a better footing; and a riding academy, with a learned fociety, have been lately eftablifhed there.

MORAVIANS, a fect of Proteftants, who have been fettled for a confiderable time paft at Hernhuth in Moravia, and have of late years fpread themfelves over moft of our American colonies, as well as in feveral parts of England, where they are permitted to fettle, by a late act of parliament. They have a kind of church-government peculiar to themfelves; and are commonly known by the name of *Unitas Fratrum*, or *The Brethren*. They profefs the utmoft veneration for our bleffed Saviour, whom they confider as their immediate head and director; enjoin the moft implicit obedience to the rulers of their church; and are faid to practife much brotherly love amongft one another; but from many of their tenets, it would appear, that obfcenity makes no fmall part of their devotion. See ZINZENDORFF.

MORBID, among phyficians, fignifies "difeafed or corrupt;" a term applied either to an unfound conftitution, or to thofe parts or humours that are affected by a difeafe.

MORBUS SACER, in medicine, the fame with HIERANOSOS. See MEDICINE, p. 4787. col. 2.

MORBUS *Regius*, the fame with the JAUNDICE. See MEDICINE, n° 453.

MORBUS, or *Difeafe*, in botany. See VARIETAS.

MORDAUNT (Charles), earl of Peterborough, a celebrated commander both by fea and land, was the fon of John Lord Mordaunt, vifcount Avalon, and was born about the year 1658. In 1675 he fucceeded his father in his honours and eftate. While young he ferved under the admirals Torrington and Narborough in the Mediterranean, againft the Algerines; and in 1680 embarked for Africa with the earl of Plymouth, and diftinguifhed himfelf at Tangier when it was befieged by the Moors.

In the reign of James II. he voted againft the repeal of the teft-act; and difliking the meafures of the court, obtained leave to go to Holland to accept the command of a Dutch fquadron in the Weft Indies. He afterwards accompanied the prince of Orange into this kingdom; and upon his advancement to the throne, was fworn of the privy-council, made one of the lords of the bedchamber to his majefty, alfo firft commiffioner of the treafury, and advanced to the dignity of earl of Monmouth. But, in November 1690, he was difmiffed from his poft in the treafury. On the death of his uncle Henry earl of Peterborough in 1697, he fucceeded to that title; and, upon the acceffion of queen Anne, was invefted with the commiffion of captain-general and governor of Jamaica. In 1705 he was fworn of the privy-council; and the fame year declared general and commander in chief of the forces fent to Spain, and joint admiral of the fleet with Sir Cloudfley Shovel, of which the year following he had the fole command. His taking Barcelona with a handful of men, and afterwards relieving it when greatly diftreffed by the enemy; his driving out of Spain the duke of Anjou, and the French army, which confifted of 25,000 men, though his own troops never amounted to 10,000; his gaining poffeffion of Catalonia, of the kingdoms of Valencia, Arragon, and the ifle of Majorca, with part of Murcia and Caftile, and thereby giving the earl of Galway an opportunity of advancing to Madrid without a blow; are aftonifhing inftances of his bravery and conduct. For thefe important fervices his Lordfhip was declared general in Spain by Charles III. afterwards emperor of Germany; and on his return to England he received the thanks of the Houfe of Lords. His Lordfhip was afterwards employed in feveral embaffies to foreign courts, inftalled knight of the garter, and made governor of Minorca. In the reign of George I. he was general of all the marine forces in Great Britain, in which poft he was continued by king George II. He died in his paffage to Lifbon, where he was going for the recovery of his health, in 1735.

His Lordfhip was diftinguifhed by his poffeffing various fhining qualities: for, to the greateft perfonal courage and refolution, he added all the arts and addrefs of a general; a lively and penetrating genius; and a great extent of knowledge upon almoft every fubject of importance within the compafs of ancient and modern literature; hence his familiar letters, inferted among thofe of his friend Mr Pope, are an ornament to that excellent collection.

MORDELLA, in zoology, a genus of the coleoptera clafs of infects. The antennæ are thread-fhaped and ferrated; the head is deflected under the neck; the pappi are clavated, compreffed, and obliquely blunted; and the elytra are bent backwards near the apex. There are fix fpecies, all natives of different parts of Europe.

MORE (Sir Thomas), lord high chancellor of England, the fon of Sir John More, knight, one of the judges of the king's-bench, was born in the year 1480, in Milk-ftreet, London. He was firft fent to a fchool at St Anthony's in Threadneedle-ftreet; and afterwards introduced into the family of cardinal Moreton, who, in 1497, fent him to Canterbury college in Oxford. During his refidence at the univerfity he conftantly attended the lectures of Linacre and Grocinus, on the Greek and Latin languages. Having in the fpace of about two years made confiderable proficiency in academical learning, he came to New-inn in London, in order to ftudy the law; whence, after fome time, he removed to Lincoln's-inn, of which his father was a member. Notwithftanding his application to the law, however, being now about 20 years old, he was fo bigotted to monkifh difcipline, that he wore a hair-fhirt next his fkin, frequently fafted, and often flept on a bare plank. In the year 1503, being then a burgefs in parliament, he diftinguifhed himfelf in the houfe, in oppofition to the motion for granting a fubfidy and three fifteenths for the marriage of Hen. VII.'s eldeft daughter, Margaret, to the king of Scotland. The motion was rejected; and the king was fo highly offended at this oppofition from a beardlefs boy, that he revenged himfelf on Mr More's father, by fending him on a frivolous pretence to the Tower, and obliging him to pay 100l. for his liberty. Being now called to the bar, he was appointed law-reader at Furnival's

 val's inn, which place he held about three years; but about this time, he alfo read a public lecture in the church of St Lawrence, Old Jewry, upon St Auftin's treatife *De civitate Dei*, with great applaufe. He had indeed formed a defign of becoming a Francifcan friar, but was diffuaded from it; and, by the advice of Dr Colet, married Jane, the eldeft daughter of John Colt, Efq; of Newhall in Effex. In 1508 he was appointed judge of the fheriff's court in the city of London, was made a juftice of the peace, and became very eminent at the bar. In 1516 he went to Flanders in the retinue of bifhop Tonftal and Dr Knight, who were fent by king Henry VIII. to renew the alliance with the archduke of Auftria, afterwards Charles V. On his return, cardinal Wolfey would have engaged Mr More in the fervice of the crown, and offered him a penfion, which he refufed. Neverthelefs, it was not long before he accepted the place of mafter of the requefts, was created a knight, admitted of the privy-council, and in 1520 made treafurer of the exchequer. About this time he built a houfe on the bank of the Thames, at Chelfea, and married a fecond wife. This wife, whofe name was *Middleton*, and a widow, was old, ill-tempered, and covetous; neverthelefs Erafmus fays he was as fond of her as if fhe were a young maid.

In the 14th year of Henry VIII. Sir Thomas More was made fpeaker of the houfe of commons: in which capacity he had the refolution to oppofe the then powerful minifter, Wolfey, in his demand of an oppreffive fubfidy; notwithftanding which, it was not long before he was made chancellor of the duchy of Lancafter, and was treated by the king with fingular familiarity. The king having once dined with Sir Thomas at Chelfea, walked with him near an hour in the garden, with his arm round his neck. After he was gone, Mr Roper, Sir Thomas's fon-in-law, obferved how happy he was to be fo familiarly treated by the king: to which Sir Thomas replied, "I thank our lord, fon Roper, I find his grace my very good lord indeed, and believe he doth as fingularly favour me as any fubject within this realm: howbeit, I muft tell thee, I have no caufe to be proud thereof; for, if my head would win him a caftle in France, it would not fail to go off." From this anecdote it appears, that Sir Thomas knew his grace to be a villain.

In 1526 he was fent, with cardinal Wolfey and others, on a joint embaffy to France, and in 1529 with bifhop Tonftal to Cambray. The king, it feems, was fo well fatisfied with his fervices on thefe occafions, that in the following year, Wolfey being difgraced, he made him chancellor; which feems the more extraordinary, when we are told that Sir Thomas had repeatedly declared his difapprobation of the king's divorce, on which the great *defenfor fidei* was fo pofitively bent. Having executed the office of chancellor about three years, with equal wifdom and integrity, he refigned the feals in 1533, probably to avoid the danger of his refufing to confirm the king's divorce. He now retired to his houfe at Chelfea; difmiffed many of his fervants; fent his children with their refpective families to their own houfes, (for hitherto he had, it feems, maintained all his children, with their families, in his own houfe, in the true ftyle of an ancient patriarch); and fpent his time in ftudy and devotion: but the capricious tyrant would not fuffer him to enjoy this tranquillity. Though now reduced to a private ftation, and even to indigence, his opinion of the legality of the king's marriage with Anne Boleyn, was deemed of fo much importance, that various means were tried to procure his approbation; but all perfuafion proving ineffectual, he was, with fome others, attainted in the houfe of lords of mifprifion of treafon, for encouraging Eliz. Barton, the nun of Kent, in her treafonable practices. His innocence in this affair appeared fo clearly, that they were obliged to ftrike his name out of the bill. He was then accufed of other crimes, but with the fame effect; till, refufing to take the oath enjoined by the act of fupremacy, he was committed to the Tower, and, after 15 months imprifonment, was tried at the bar of the king's-bench, for high treafon, in denying the king's fupremacy. The proof refted on the fole evidence of Rich the folicitor-general, whom Sir Thomas, in his defence, fufficiently difcredited: neverthelefs the jury brought him in guilty, and he was condemned to fuffer as a traitor. The merciful Harry however indulged him with fimple decollation; and he was accordingly beheaded on Tower-hill, on the 5th of July 1535. His body, which was firft interred in the Tower, was begged by his daughter Margaret, and depofited in the chancel of the church at Chelfea, where a monument, with an infcription written by himfelf, had been fome time before erected. This monument with the infcription is ftill to be feen in that church. The fame daughter, Margaret, alfo procured his head after it had remained 14 days upon London-bridge, and placed it in a vault belonging to the Roper's family, under a chapel adjoining to St Dunftan's church in Canterbury. Sir Thomas More was a man of fome learning, and an upright judge; a very prieft in religion, yet cheerful, and even affectedly witty (A). He wanted not fagacity, where religion was out of the queftion; but in that his faculties were fo enveloped, as to render him a weak and credulous enthufiaft. He left one fon and three daughters; Margaret, the eldeft of which, was very remarkable for her knowledge of the Greek and Latin languages. She married a Mr Roper of Well-hall in Kent, whofe Life of Sir Thomas More was publifhed by Mr Hearne at Oxford, in 1716. Mrs Roper died in 1544; and was buried in the vault of St Dunftan's in Canterbury, with her father's head in her arms.

Sir Thomas was the author of various works, tho' his *Utopia* is the only performance that has furvived in the efteem of the world; owing to the reft being chiefly of a polemic nature: his anfwer to Luther has only gained him the credit of having the beft knack of any man in Europe, at calling bad names in good Latin. His

(A) This laft difpofition, we are told, he could not reftrain even at his execution. The day being come, he afcended the fcaffold, which feemed fo weak, that it was ready to fall; whereupon, "I pray (faid he) fee me fafe up, and for my coming down let me fhift for myfelf." His prayers being ended, he turned to the executioner, and with a cheerful countenance faid, "Pluck up thy fpirits, man, and be not afraid to do thy office; my neck is very fhort, take heed therefore thou ftrike not awry for faving thy honefty." Then laying his head upon the block, he bid him ftay until he had put afide his beard, faying, "That had never committed any treafon."

His Englifh works were collected and publifhed by order of queen Mary, in 1557; his Latin, at Bafil in 1563, and at Louvain in 1566.

More (Henry), an eminent Englifh divine and philofopher, in the 17th century, was educated at Eton fchool, and in Chrift-college in Cambridge, of which he became a fellow, and fpent his life in a retired way, publifhing a great number of excellent works. He refufed bifhoprics both in Ireland and England. He was an open-hearted, fincere Chriftian philofopher, who ftudied to eftablifh men in the belief of providence againft atheifm. Mr Hobbes was ufed to fay, that if his own philofophy was not true, there was none that he fhould fooner like than our philofopher's. His writings have been publifhed together in Latin and Englifh, folio.

MOREA, formerly called the *Peloponnefus*, is a peninfula to the fouth of Greece, to which it is joined by the ifthmus of Corinth. Its form refembles a mulberry-leaf, and its name is derived from the great number of mulberry-trees which grow there. It is about 180 miles in length, and 130 in breadth. The air is temperate, and the land fertile, except in the middle, where it is full of mountains, and is watered by a great number of rivers. It is divided into three provinces; Scania, Belvedera, and Brazzo-di-Maina. It was taken from the Turks by the Venetians in 1687; but they loft it again in 1715. The fangiac of the Morea refides at Modon. See Greece and Peloponnesus.

MOREAU (James), an eminent French phyfician, born at Chalons-fur-Saone, was the difciple and friend of the famous Guy Patin. He drew upon himfelf the jealoufy and hatred of the old phyficians by the public thefes he maintained, and afterwards vindicated in his writings. He died in a very advanced age, in 1729. He wrote in French, 1. Confultations on the Rheumatifm. 2. A chemical treatife on Fevers. 3. A phyfical differtation on the Dropfy; and other works which are efteemed.

MOREL, the name of feveral celebrated printers to the kings of France, who, like the Stephens's, were alfo men of great learning. William Morel died at Paris in 1564. Frederic Morel, who was alfo interpreter in the Greek and Latin tongues, as well as printer to the king, died in 1583. He left a fon of his own name, who became more famous than his father; and who had fo ftrong an attachment to ftudy, that when he was informed of his wife's being at the point of death he would not lay down his pen till he had finifhed what he was upon; and when fhe was dead, as fhe was before they could prevail upon him to ftir, he was only heard to reply coldly; "I am very forry; fhe was a good woman." This Frederic Morel died in June 1630, aged 38 years, after having printed a great number of authors in fuch a manner as fhew him to have been a very learned and ingenious man. His fons and grandfons trode in his fteps; they diftinguifhed themfelves in literature, and maintained alfo the reputation which he had acquired by printing.

Morel (Andreas), a very eminent antiquary, born at Berne in Switzerland. Having a ftrong paffion for the ftudy of medals, he travelled through feveral countries, and made large collections: in 1683 he publifhed at Paris in 8vo, *Specimen univerfæ rei nummariæ antiquæ;* and the great work of which this was the fpecimen, was to be a complete collection of all ancient medals, of which he had at that time 20,000 exactly defigned. Soon after this effay appeared, Lewis XIV. gave him a place in his cabinet of antiques, in which capacity he brought himfelf into great danger by fpeaking too freely of M. Louvois on account of the neglect in paying his falary, or on fome other private account; as he was committed to the Baftile, where he lay for three years: nor was he releafed until the death of Louvois, nor till the canton of Berne had interceded in his favour. He afterward accepted an invitation from the count of Schwartzburg at Arnftadt in Germany, with whom he lived in the capacity of antiquary, and was furnifhed with every thing neceffary for carrying on his grand work. In 1703 he died; and in 1734 came out at Amfterdam part of this collection, in 2 vols folio, under the title of *Thefaurus Morellianus, five familiarum Romanorum numifmata omnia, diligentiffime undique conquifita*, &c. *Nunc primum edidit & commentario perpetuo illuftravit Sigibertus Havercampus.* Thefe volumes contain an explication of 3539 medals, engraved, with their reverfes.

MORENA, (anc. geog.), a diftrict or divifion of Myfia, in the Hither Afia. A part of which was occupied by Cleon, formerly at the head of a band of robbers; but afterwards prieft of Jupiter Abrettenus, and enriched with poffeffions, firft by Antony, and then by Cæfar.

MORRERI (Lewis), author of the Hiftorical Dictionary, was born at Bargemont in Provence 1643. He learned rhetoric and philofophy at Aix, and divinity at Lyons. At 18 years of age he wrote a fmall piece, intitled *Le Pays d'Amour;* and a collection of the fineft French poems, intitled *Doux plaifirs de la Poefie.* He learned Spanifh and Italian; and tranflated out of Spanifh into French, the book intitled *La Perfection Chretienne de Rodriguez.* He then refined the Saints Lives to the purity of the French tongue. Being ordained prieft, he preached at Lyons; and undertook, when he was but 30 years of age, a new Hiftorical Dictionary, printed at Lyons in one vol. folio, 1673. But his continual labour impaired his health; fo that he died in 1680, aged 37. His fecond volume was publifhed after his death; and four more volumes have fince been added. He left fome other works behind him.

MORESK, or Morisco, is a kind of painting, carving, &c. done after the manner of the Moors; confifting of feveral grotefque pieces and compartments, promifcuoufly mingled, not containing any perfect figure of a man, or other animal; but a wild refemblance of birds, beafts, trees, &c.

MORGAGNI (John Baptift), doctor of medicine, firft profeffor of anatomy in the univerfity of Padua, and member of feveral of the moft eminent focieties of learned men in Europe, was born in the year 1682, at Forli, a town in the diftrict of *La Romagna* in Italy. His parents, who were in eafy circumftances, allowed him to follow that courfe in life his genius dictated. He began his ftudies at the place of his nativity; but foon after removed to Bologna, where he obtained the degree of Doctor of Medicine, when he had but juft reached the 16th year of his age. Here his peculiar tafte for anatomy found an able preceptor in Valfalva, who beftowed on him the utmoft attention; and, fuch was the

Morgagni.

the progreſs he made under this excellent maſter, that at the age of 20 he himſelf taught anatomy with high reputation. Soon, however, the fame of his prelections, and the number of his pupils, excited the jealouſy of the public profeſſors, and gave riſe to invidious perſecutions. But his abilities and prudence gained him a complete triumph over his enemies; and all oppoſition to him was finally terminated from his being appointed by the ſenate of Bologna to fill a medical chair, which ſoon became vacant. But the duties of this office, although important, neither occupied the whole of his time, nor ſatisfied his anxious deſire to afford inſtruction. He ſtill continued to labour in ſecret on his favourite ſubject, and ſoon after communicated the fruits of theſe labours to the public in his *Adverſaria Anatomica*, the firſt of which was publiſhed in the year 1706, the ſecond and third in 1717, and the three others in 1719. The publication of this excellent work ſpread the fame of Morgagni far beyond the limits of the ſtate of Bologna. Such was his reputation, that the wiſe republic of Venice had no heſitation in making him an offer of the ſecond chair of the theory of medicine in the univerſity of Padua, then vacant by the death of Mr Molinetti; and, to enſure his acceptance, they doubled the emoluments of that appointment. While he was in this department, he publiſhed his treatiſe, entitled *Nova inſtitutionum medicarum idea*, which firſt appeared at Padua in the year 1712. From this work his former reputation ſuffered no diminution. And ſoon after he roſe, by different ſteps, to be firſt profeſſor of anatomy in that celebrated univerſity. Although Morgagni was thus finally ſettled at Padua, yet he gave evident proofs of his gratitude and attachment to Bologna, which he conſidered as his native country with reſpect to the ſciences. He exerted his utmoſt efforts in eſtabliſhing the academy of Bologna, of which he was one of the firſt aſſociates; and he enriched their publications with ſeveral valuable and curious papers. Soon after this, the royal ſocieties of London and Paris received him among their number. Not long after the publication of his *Adverſaria Anatomica*, he began, much upon the ſame plan, his *Epiſtolæ Anatomicæ*, the firſt of which is dated at Padua in the beginning of April 1726. The works of Morgagni which have already been mentioned, are to be conſidered, in a great meaſure, as ſtrictly anatomical; but he was not more eminent as an anatomiſt, than as a learned and ſucceſsful phyſician. In the year 1760, when he was not far diſtant from the 80th year of his age, he publiſhed his large and valuable work *De cauſis et ſedibus morborum per anatomen indagatis*. This laſt and moſt important of all his productions will afford convincing evidence of his induſtry and abilities to lateſt poſterity. Beſides theſe works, he publiſhed, at different periods of his life, ſeveral miſcellaneous pieces, which were afterwards collected into one volume, and printed under his own eye at Padua, in the year 1765. It does not appear that he had in view any future publications; but he intended to have favoured the world with a complete edition of all his works, which would probably have been augmented with many new obſervations. In this he was engaged, when, on the 5th of December 1771, after he had nearly arrived at the 90th year of his age, death put a period to his long and glorious career in the learned world.

Morhoff || Morin.

MORHOFF (Daniel George), a very learned German, born at Wiſmar in the duchy of Mecklenburgh, in 1639. The duke of Holſtein, when he founded an univerſity at Kiel, made him profeſſor of eloquence and poetry there in 1665; to which was afterwards added the profeſſorſhip of hiſtory, and in 1680 the office of librarian to the univerſity. He was the author of many works of a ſmall kind; as orations, diſſertations, theſes, and poems: but his chief work was his *Polyhiſtor, ſive de notitia auctorum & rerum commentarii;* firſt publiſhed at Lubec in 1688; which has been greatly enlarged ſince his death in 1691, and gone through ſeveral ſucceſſive editions.

MORIAH, one of the eminences of Jeruſalem; on which Abraham went to offer his ſon, and David wanted to build the temple, which was afterwards executed by Solomon: The threſhing-floor of Araunah; originally narrow, ſo as ſcarce to contain the temple, but enlarged by means of ramparts; and ſurrounded with a triple wall, ſo as to add great ſtrength to the temple, (Joſephus). It may be conſidered as a part of Mount Sion, to which it was joined by a bridge and gallery, (*Id.*).

MORIN (John Baptiſt), phyſician and regius profeſſor of mathematics at Paris, was born at Villefranche in Beaufolois, in 1583. After commencing doctor at Avignon, he went to Paris, and lived with Claude Dormi biſhop of Boulogne, who ſent him to examine the mines of Hungary; and thereby gave occaſion to his *Mundus ſublunaris anatomia*, which was his firſt production, and publiſhed in 1619. Upon his return to his patron the biſhop, he contracted an attachment to judicial aſtrology, concerning which he furniſhed the world with many ridiculous ſtories, and wrote a great number of books not worth enumerating. He died in 1656, before he had finiſhed the favourite labour of life, which was his *Aſtrologia Gallica*. Louiſa Maria de Gonzaga queen of Poland gave 2000 crowns to carry on the edition, at the recommendation of one of her ſecretaries, who was a lover of aſtrology; and it appeared at the Hague in 1661, in one vol. folio, with two dedications, one to Jeſus Chriſt, and another to the queen of Poland.

MORIN (John), a very learned Frenchman, born at Blois, of Proteſtant parents, in 1591; but converted by cardinal du Perron to the catholic religion. He publiſhed, in 1626, ſome Exercitations upon the original of patriarchs and primates, and the ancient uſage of eccleſiaſtical cenſures; dedicated to pope Urban VIII. In 1628 he undertook the edition of the Septuagint Bible, with Nobilius's verſion; and placed a preface before it, in which he treats of the authority of the Septuagint, and prefers the verſion in the edition made at Rome by order of Sixtus V. to the preſent Hebrew text, which he affirms has been corrupted by the Jews. About the ſame time he gave a French hiſtory of the deliverance of the church by the emperor Conſtantine; and of the temporal greatneſs conferred on the Roman church by the kings of France. He afterwards publiſhed Exercitations upon the Samaritan Pentateuch; and took the care of the Samaritan Pentateuch, for the Polyglot then preparing at Paris. He was greatly careſſed at Rome; where, after living nine years, at the invitation of cardinal Bar-

barini, he was recalled by cardinal Richlieu, and died at Paris in 1659. His works are very numerous; and fome of them as much valued by Proteftants as Papifts for the oriental learning they contain.

MORINUS (Stephen), a learned French Proteftant, born at Caen in 1625. He became minifter of two churches near Caen, and in 1664 was chofen minifter of Caen; but on the revocation of the edict of Nantz, was obliged to take refuge in Holland. He was foon called to be profeffor of the oriental tongues at Amfterdam, to which employment was afterwards joined that of minifter in ordinary: he died in 1700. He was the author of feveral works: and his fondnefs for the Hebrew language made him run into fome extravagancies concerning it; for in his *Lettre fur l'origine de la langue Hebraïque*, he endeavours to prove that language as old as the creation, and that God himfelf infpired it into Adam. This was anfwered by Huet.

MORISON (Robert), phyfician and profeffor of botany at Oxford, was born at Aberdeen in 1620, bred at the univerfity there, and taught philofophy for fome time in it; but having a ftrong inclination to botany, made great progrefs in it. The civil wars obliged him to leave his country; which, however, he did not do till he had firft fignalized his zeal for the intereft of the king, and his courage, in a battle fought between the inhabitants of Aberdeen and the Prefbyterian troops on the bridge of Aberdeen, in which he received a dangerous wound on the head. As foon as he was cured of it, he went into France; and fixing at Paris, he applied affiduoufly to botany and anatomy. He was introduced to the duke of Orleans, who gave him the direction of the royal gardens at Blois. He exercifed the office till the death of that prince, and afterwards went over to England in 1660. Charles II. to whom the duke of Orleans had prefented him at Blois, fent for him to London, and gave him the title of his *phyfician*, and that of *profeffor royal of botany*, with a penfion of 200l. *per annum*. The *Præludium Botanicum*, which he publifhed in 1669, procured him fo much reputation, that the univerfity of Oxford invited him to the profefforfhip of botany in 1669; which he accepted, and acquitted himfelf in it with great ability. He died at London in 1683, aged 63. He publifhed a fecond and third part of his Hiftory of Plants, in 2 vols, folio; with this title *Plantarum Hiftoria Oxonienfis Univerfalis*. The firft part of this excellent work has not been printed; and it is not known what has become of it.

MORLACHIA, a mountainous country of Dalmatia. The inhabitants are called *Morlacks* or *Morlacchi;* and inhabit the pleafant valleys of Koter, along the rivers Kerha, Cettina, Narenta, and among the inland mountains of Dalmatia. The inhabitants are by fome faid to be of Walachian extraction, as (according to thefe authors), is indicated even by their name; Morlachia being a contraction of *Mauro-Walachia*, that is, *black Walahica:* and the Walachians are faid to be defcendents of the ancient Roman colonies planted in thefe countries. This however is denied by the abbe Fortis, who hath publifhed a volume of travels into that country. He informs us, that the origin of the Morlacchi is involved in the darknefs of barbarous ages, together with that of many other nations, refembling them fo much in cuftoms and language, that they may be taken for one people, difperfed in the vaft tracks from the Adriatic fea to the frozen ocean. The emigrations of the various tribes of the Slavi, who, under the names of *Scythians*, *Geti*, *Goths*, *Hunns*, *Slavini*, *Croats*, *Avari*, and *Vandals*, invaded the Roman empire, and particularly the Illyrian provinces during the decline of the empire, muft have ftrangely perplexed the genealogies of the nations which inhabited it, and which perhaps removed thither in the fame manner as at more remote periods of time. The remainder of the Ardiæi, Autariati, and other Illyrian people anciently fettled in Dalmatia, who probably could not reconcile themfelves to a dependence on the Romans, might neverthelefs naturally enough form an union with foreign invaders not unlike themfelves in dialect and cuftoms; and, according to our author, it feems no ill-founded conjecture, that many families, driven out of Hungary by the irruption of the Moguls under Jenghiz Khan and his fucceffors, might people the deferted valleys between the mountains of Dalmatia. This conjecture is alfo fomewhat confirmed by the traces of the Calmuck Tartars, which are ftill to be found in a part of that country called *Zara*.

With regard to the etymology of the name, the abbe obferves, that the Morlacchi generally call themfelves, in their own language, *Vlaffi;* a national term, of which no veftige is found in the records of Dalmatia till the 13th century. It fignifies *powerful men*, or *men of authority*, and the denomination of *Moro-Vlaffi*, corruptly *Morlacchi*, as they are now called, may perhaps point out the original of the nation. This word may poffibly fignify the *conquerors that came from the fea; Moor*, in all the dialects of the Sclavonian language, fignifying the *fea*.

The Morlacchi are fo different from the inhabitants of the fea-coafts in dialect, drefs, difpofitions, and cuftoms, that they feem clearly to be of a different original, or at leaft the colonies muft have fettled at fuch diftant periods from each other, that they have had time to alter in a great meafure their national character. There is alfo a remarkable diverfity among the Morlacchi themfelves in feveral diftricts, probably on account of the different countries from whence they came.

With regard to the character of thefe people, we are informed that they are much injured by their maritime neighbours. The inhabitants of the fea-coaft of Dalmatia tell many frightful ftories of their avarice and cruelty: but thefe, in our author's opinion, are all either of an ancient date; or if any have happened in latter times, they ought rather to be afcribed to the corruption of a few individuals, than to the bad difpofition of the nation in general; and though thievifh tricks are frequent among them, he informs us, that a ftranger may travel fecurely through their country, where he is faithfully efcorted, and hofpitably treated. The greateft danger is from the *Haiduks* or *Banditti*, of whom their are great numbers among the woods and caves of thefe dreadful mountains on the confines. There, fays our author, a man ought to get himfelf efcorted by a couple of thefe "honeft fellows;" for they are not capable of betraying him, although a banditti; and their fituation is commonly more apt to raife compaffion than diffidence. They lead their life among

Morlachia. among the wolves, wandering from one precipice to another, expofed to the feverity of the feafons, and frequently languifh in want of the neceffaries of life, in the moft hideous and folitary caverns. Yet they very feldom difturb the tranquillity of others, and prove always faithful guides to travellers; the chief objects of their rapine being fheep and oxen, to fupply themfelves with food and fhoes. Sometimes it happens, that, in their extreme neceffity, the Haiduks go in parties to the fhepherds cottages, and rudely demand fomething to eat; which they do not fail to take immediately by force if the leaft hefitation is made. It is feldom indeed that they meet with a refufal, or with refiftance, as their refolution and fury are well known to be equal to the favage life they lead. Four Haiduks are not afraid to affualt a caravan of 15 or 20 Turks, and generally plunder and put them to flight. The greateft part of the Haiduks look upon it as a meritorious action to fhed the blood of the Turks; to which cruelty they are eafily led by their natural ferocity, inflamed by a miftaken zeal for religion, and the difcourfes of their fanatic priefts.

As to the Morlacchi themfelves, they are reprefented as open and fincere to fuch a degree, that they would be taken for fimpletons in any other country; and by means of this quality they have been fo often duped by the Italians, that *the faith of an Italian*, and *the faith of a dog*, are fynonimous among the Morlacchi. They are very hofpitable to ftrangers, and their hofpitality is equally confpicuous among the rich and poor. The rich prepares a roafted lamb or fheep, and the poor with equal cordiality offers whatever he has; nor is this generofity confined to ftrangers, but generally extends itfelf to all who are in want. When a Morlack is on a journey, and comes to lodge at a friend's houfe, the eldeft daughter of the family, or the new-married bride if there happens to be one, receives and kiffes him when he alights from his horfe or at the door of the houfe: but a foregner is rarely favoured with thefe female civilities; on the contrary, the women, if they are young, hide themfelves, and keep out of his way.

The Morlacchi in general have little notion of domeftic œconomy, and readily confume in a week as much as would be fufficient for feveral months, whenever any occafion of merriment prefents itfelf. A marriage, the holiday of the faint, protector of the family, the arrival of relations or friends, or any other joyful incident, confumes of courfe all that there is to eat and to drink in the houfe. Yet the Morlack is a great œconomift in the ufe of his wearing-apparel; for, rather than fpoil his new cap, he takes it off, let it rain ever fo hard, and goes bareheaded in the ftorm. In the fame manner he treats his fhoes, if the road is dirty and they are not very old. Nothing but an abfolute impoffibility hinders a Morlack from being punctual; and if he cannot repay the money he borrowed at the appointed time, he carries a fmall prefent to his creditor, and requefts a longer term. Thus it happens fometimes, that, from term to term, and prefent to prefent, he pays double what he owed, without reflecting on it.

Friendfhip, that among us is fo fubject to change on the flighteft motives, is lafting among the Morlacchi. They have even made it a kind of religious point, and tie the facred bond at the foot of the altar. The Sclavonian ritual contains a particular benediction for the folemn union of two male or two female friends in the prefence of the congregation. The male friends thus united are called *Pobratimi*, and the female *Pofeftreme*, which mean half-brothers and half-fifters. Friendfhips between thofe of different fexes are not at this day bound with fo much folemnity, though perhaps in more ancient and innocent ages it was alfo the cuftom. Morlachia.

From thefe confecrated friendfhips among the Morlacchi and other nations of the fame origin, it fhould feem that the *fworn brothers* arofe, a denomination frequent enough among the common people of Italy, and in many parts of Europe. The difference between thefe and the Pobratimi of Morlacchia confifts not only in the want of the ritual ceremony, but in the defign of the union itfelf. For, among the Morlacchi, the fole view is reciprocal fervice and advantage; but fuch a brotherhood among the Italians, is generally commenced by bad men, to enable them the more to hurt and difturb fociety. The duties of the Pobratimi are, to affift each other in every cafe of need or danger, to revenge mutual wrongs, and fuch like. The enthufiafm is often carried fo far as to rifk and even to lofe their life for the Pobratimi, although thefe favage friends are not celebrated like a Pylades. If difcord happens to arife between two friends, it is talked of over all the country as a fcandalous novelty; and there has been fome examples of it of late years, to the great affliction of the old Morlacchi, who attribute the depravation of their countrymen to their intercourfe with the Italians. Wine and ftrong liquors, of which the nation is beginning to make daily abufe, will of courfe produce the fame bad effects as among others.

But as the friendfhips of the Morlacchi are ftrong and facred, fo their quarrels are commonly unextinguifhable. They pafs from father to fon; and the mothers fail not to put their children in mind of their duty to revenge their father if he has had the misfortune to be killed, and to fhew them often the bloody fkirt and arms of the deed. And fo deeply is revenge rooted in the minds of this nation, that all the miffionaries in the world would not be able to eradicate it. A Morlack is naturally inclined to do good to his fellow-creatures, and is full of gratitude for the fmalleft benefit; but implacable if injured or infulted.

A Morlack who has killed another of a powerful family, is commonly obliged to fave himfelf by flight, and to keep out of the way for feveral years. If during that time he has been fortunate enough to efcape the fearch of his purfuers, and has got a fmall fum of money, he endeavours to obtain pardon and peace; and, that he may treat about the conditions in perfon, he afks and obtains a fafe conduct, which is faithfully maintained, through only verbally granted. Then he finds mediators; and, on an appointed day, the relations of the two hoftile families are affembled, and the criminal is introduced, dragging himfelf along on his hands and feet, the mufket, piftol, or cutlafs, with which he committed the murder, hung about his neck; and while he continues in that humble pofture, one or more of the relations recites a panegyric on the

Morlachia. the dead, which fometimes rekindles the flames of revenge, and puts the poor proftrate in no fmall danger. It is the cuftom in fome places for the offended party to threaten the criminal, holding all kind of arms to his throat, and, after much intreaty, to confent at leaft to accept of his ranfom. Thefe pacifications coft dear in Albania; but the Morlacchi make up matters fometimes at a fmall expence; and every-where the bufinefs is concluded with a feaft at the offender's charge.

The Morlacks, whether they happen to be of the Roman or of the Greek church, have very fingular ideas about religion; and the ignorance of their teachers daily augments this monftrous evil. They are as firmly perfuaded of the reality of witches, fairies, enchantments, nocturnal apparitions, and fortileges, as if they had feen a thoufand examples of them. Nor do they make the leaft doubt about the exiftence of vampires; and attribute to them, as in Tranfylvania, the fucking the blood of infants. Therefore, when a man dies fufpected of becoming a vampire, or *vukodlak*, as they call it, they cut his hams, and prick his whole body with pins; pretending, that after this operation he cannot walk about. There are even inftances of Morlacchi, who, imagining that they may poffibly thirft for childrens blood after death, intreat their heirs, and fometimes oblige them, to promife to treat them as vampires when they die.

The boldeft Haiduk would fly trembling from the apparition of a fpectre, ghoft, phantom, or fuch like goblins as the heated imaginations of credulous and prepoffeffed people never fail to fee. Nor are they afhamed, when ridiculed for this terror; but anfwer, much in the words of Pindar: "Fear that proceeds from fpirits, caufes even the fons of the gods to fly." The women, as may be naturally fuppofed, are a hundred times more timorous and vifionary than the men; and fome of them, by frequently hearing themfelves called *witches*, actually believe they are fo.

A moft perfect difcord reigns in Morlachia, as it generally does in other parts, between the Latin and Greek communion, which their refpective priefts fail not to foment, and tell a thoufand little fcandalous ftories of each other. The churches of the Latins are poor, but not very dirty: thofe of the Greeks are equally poor, and fhamefully ill kept. Our author has feen the curate of a Morlack village fitting on the ground in the church-yard, to hear the confeffion of women on their knees by his fide: a ftrange pofture indeed! but a proof of the innocent manners of thofe good people, who have the moft profound veneration for their fpiritual paftors, and a total dependence upon them; who, on their part, frequently make ufe of a difcipline rather military, and correct the bodies of their offending flock with the cudgel. Perhaps this particular is carried to an abufe as well as that of public penance, which they pretend to inflict after the manner of the ancient church. They moreover, thro' the filly credulity of thofe poor mountaineers, draw illicit profits, by felling certain fuperftitious fcrolls and other fcandalous merchandife of that kind. They write in a capricious manner, on the fcrolls called *zapiz*, facred names which ought not to be trifled with, and fometimes adding others very improperly joined. The virtues attributed to thefe zapiz are much of the fame nature as thofe which the Bafilians attributed to their monftruoufly cut ftones. The Morlacchi ufe to carry them fewed to their caps, to cure or to prevent difeafes; and they alfo tie them for the fame purpofe to the horns of their oxen. The compofers of this trumpery take every method to maintain the credit of their profitable trade, in fpite of its abfurdity, and the frequent proofs of its inutility. And fo great has their fuccefs been, that not only the Morlacchi, but even the Turks near the borders, provide themfelves plentifully with zapiz from the Chriftian priefts, which not a little increafes their income, as well as the reputation of the commodity. The Morlacchi have alfo much devotion, and many of the ignorant people in Italy have little lefs, to certain copper and filver coins of the low empire; or to Venetian cotemporary pieces, which pafs among them for medals of St Helen; and they think they cure the epilepfy and fuch like. They are equally fond of an Hungarian coin called *petizza*, which has the virgin and child on the reverfe; and one of thefe is a moft acceptable prefent to a Morlack. Morlachia.

The bordering Turks not only keep with devotion the fuperftitious zapiz, but frequently bring prefents and caufe maffes to be celebrated to the images of the Virgin; which is doubtlefs in contradiction to the alcoran; yet when faluted, in the ufual manner in that country, by the name of *Jefus*, they do not anfwer. Hence, when the Morlacchi, or other travellers, meet them on the confines, they do not fay, *Huaglian Iffus*, "Jefus be praifed;" but, *Huaglian Bog*, "God be praifed."

Innocence, and the natural liberty of paftoral ages, are ftill preferved among the Morlacchi, or at leaft many traces of them remain in the places fartheft diftant from our fettlements. Pure cordiality of fenti ment is not there reftrained by other regards, and difplays itfelf without any diftinction of circumftances. A young handfome Morlack girl, who meets a man of her diftrict on the road, kiffes him affectionately, without the leaft malice or immodeft thought; and our author has feen all the women and girls, all the young men and old, kiffing one another as they came into the church-yard on a holiday; fo that they looked as if they had been all belonging to one family. He hath often obferved the fame thing on the road, and at the fairs in the maritime towns, where the Morlacchi came to fell their commodities. In times of feafting and merriment, befides the kiffes, fome other little liberties are taken with the hands, which we would not reckon decent, but are not minded among them; and when they are told of it, they anfwer, it is only toying, and means nothing. From this toying, however, their amours often take their beginning, and frequently end ferioufly when the two lovers are once agreed. For it very rarely happens, in places far diftant from the coaft, that a Morlacco carries off a girl againft her will, or difhonours her: and were fuch attempts made, the young woman would, no doubt, be able to defend herfelf; the women in that country being generally very little lefs robuft than the men. But the cuftom is for the woman herfelf to appoint the time and place of being carried off; and fhe does fo in order to extricate herfelf from other fuitors, from whom fhe may have received fome love-token, fuch as a brafs ring, a little

little knife, or fuch like trifles. The Morlack women keep themfelves fomewhat neat till they get a hufband; but after marriage they abandon themfelves totally to a loathfome dirtinefs, as if they intended to juftify the contempt with which they are treated. Indeed it cannot be faid that even the young women have a grateful odour, as they are ufed to anoint their hair with butter, which foon becoming rancid exhales no agreeable effluvia.

The drefs of the unmarried women is the moft complex and whimfical, in refpect to the ornaments of the head; for when married they are not allowed to wear any thing elfe but a handkerchief, either white or coloured, tied about it. The girls ufe a fcarlet cap, to which they commonly hang a veil falling down on the fhoulders, as a mark of their virginity. The better fort adorn their caps with ftrings of filver coins, among which are frequently feen very ancient and valuable ones; they have moreover ear-rings of very curious work, and fmall filver chains with the figures of half moons faftened to the ends of them. But the poor are forced to content themfelves with plain caps; or if they have any ornaments, they confift only of fmall exotic fhells, round glafs beads, or bits of tin. The principal merit of thefe caps, which conftitute the good tafte as well as vanity of the Morlack young ladies, is to attract and fix the eyes of all who are near them by the multitude of ornaments, and the noife they make on the leaft motion of their heads. Hence half-moons of filver, or of tin, little chains and hearts, falfe ftones and fhells, together with all kind of fplendid trumpery, are readily admitted into their head-drefs. In fome diftricts, they fix tufts of various coloured feathers, refembling two horns on their caps; in others, tremulous plumes of glafs; and in others, artificial flowers, which they purchafe in the fea-port towns; and in the variety of thofe capricious and barbarous ornaments, fometimes a fancy not inelegant is difplayed. Their holiday-fhifts are embroidered with red filk, and fometimes with gold, which they work themfelves while they attend their flocks; and it is furprifing to fee how nicely this work is executed. Both old and young women wear about their necks large ftrings of round glafs-beads of various fize and colour; and many rings of brafs, tin, or filver, on their fingers. Their bracelets are of leather covered with wrought tin or filver; and they embroider their ftomachers, or adorn them with beads or fhells. But the ufe of ftays is unknown, nor do they put whalebone or iron in the ftomacher. A broad woollen girdle furrounds their petticoat, which is commonly decked with fhells, and of blue colour, and therefore called *modrina*. Their gown, as well as petticoat, is of a kind of ferge; and both reach near to the ankle: the gown is bordered with fcarlet, and called *fadak*. They ufe no modrina in fummer, and only wear the fadak without fleeves over a linen petticoat or fhift. The girls always wear red ftockings; and their fhoes are like thofe of the men, called *opanke*. The fole is of undreffed ox-hide, and the upper part of fheeps-fkin thongs knotted, which they call *apute;* and thefe they faften above the ankles, fomething like the ancient coturnus.

The unmarried women, even of the richeft females, are not permitted to wear any other fort of fhoes; tho' after marriage they may, if they will, lay afide the opanke, and ufe the Turkifh flippers. The girls keep their hair treffed under their caps, but when married they let it fall difhevelled on the breaft; fometimes they tie it under the chin; and always have medals, beads, or bored coins, in the Tartar or American mode, twifted amongft it. An unmarried woman, who falls under the imputation of want of chaftity, runs the rifk of having her red cap torn off her head publicly in church by the curate, and her hair cut by fome relation, in token of infamy. Hence, if any of them happen to have fallen into an illicit amour, they commonly of their own accord lay afide the badge of virginity, and remove into another part of the country.

Nothing is more common among the Morlacchi than marriages concluded between the old people of the refpective families, efpecially when the parties live at a great diftance, and neither fee nor know each other; and the ordinary motive of thefe alliances is the ambition of being related to a numerous and powerful family, famous for having produced valiant men. The father of the future bridegroom, or fome other near relation of mature age, goes to afk the young woman, or rather a young woman of fuch a family, not having commonly any determinate choice. Upon this, all the girls of the houfe are fhewn to him, and he choofes which pleafes him beft, though generally refpecting the right of feniority. A denial in fuch cafes is very rare, nor does the father of the maid inquire much into the circumftances of the family that afks her. Sometimes a daughter of the mafter is given in marriage to the fervant or tenant, as was ufual in patriarchal times; fo little are the women regarded in this country. On thefe occafions, however, the Morlacchi girls enjoy a privilege which ours would alfo wifh to have, as in juftice they certainly ought. For he who acts by proxy, having obtained his fuit, is obliged to go and bring the bridegroom; and if, on feeing each other, the young people are reciprocally content, the marriage is concluded, but not otherwife. In fome parts it is the cuftom for the bride to go to fee the houfe and family of the propofed hufband, before fhe gives a definitive anfwer; and if the place or perfons are difagreeable to her, fhe is at liberty to annul the contract. But if fhe is contented, fhe returns to her father's houfe, efcorted by the bridegroom and neareft relations. There the marriage-day is appointed; on which the bridegroom comes to the bride's houfe, attended by all his friends of greateft note, who on this occafion are called *fvati*, and are all armed, and on horfeback, in their holiday-cloaths, with a peacock's feather in their cap, which is the diftinctive ornament ufed by thofe who are invited to weddings. The company goes armed, to repulfe any attack or ambufh that might be intended to difturb the feaft: for in old times thefe encounters were not unfrequent, according to the records of many national heroic fongs.

The bride is conducted to a church, veiled, and furrounded by the fvati on horfeback; and the facred ceremony is performed amidft the noife of mufkets, piftols, barbaric fhouts and acclamations, which continue till fhe returns to her father's houfe, or to that of her hufband if not far off. Each of the fvati has his parti-

Morlachia. particular inſpection, as well during the cavalcade, as at the marriage feaſt, which begins immediately on their return from church. The parvinaz precedes all the reſt, ſinging ſuch ſongs as he thinks ſuitable to the occaſion. The bariactar brandiſhes a lance with a ſilken banner faſtened to it, and an apple ſtuck on the point; there are two bariactars, and ſometimes four, at the more noble marriages. The ſtari-ſvat is the principal perſonage of the brigade, and the moſt reſpectable relation is commonly inveſted with this dignity. The ſtacheo's duty is to receive and obey the orders of the ſtari-ſvat. The two diveri, who ought to be the bridegroom's brothers when he has any, are appointed to ſerve the bride. The knum correſponds to our ſponſors; and the komorgia, or ſekſana is deputed to receive and guard the dowery. A ciaous carries the mace, and attends to the order of the march, as maſter of the ceremonies; he goes ſinging aloud, *Breberi*, *Davori*, *Dobraſrichia*, *Jara*, *Pico*, names of ancient propitious deities. Buklia is the cup-bearer of the company, as well on the march as at table; and all theſe offices are doubled, and ſometimes tripled, in proportion to the number of the company.

The firſt day's entertainment is ſometimes made at the bride's houſe, but generally at the bridegroom's, whither the ſvati haſten immediately after the nuptial benediction; and at the ſame time, three or four men run on foot to tell the good news; the firſt who gets to the houſe has a kind of towel, embroidered at the ends, as a premium. The domachin, or head of the houſe, comes out to meet his daughter-in-law; and a child is handed to her, before ſhe alights, to careſs it; and if there happens to be none in the houſe, the child is borrowed from one of the neighbours. When ſhe alights, ſhe kneels down, and kiſſes the threſhold. Then the mother-in-law, or, in her place, ſome other female relation, preſents a corn-ſieve, full of different kinds of grain, nuts, almonds, and other ſmall fruit, which the bride ſcatters upon the ſvati, by handfuls behind her back. The bride does not ſit at the great table the firſt day, but has one apart for herſelf, the two diveri, and the ſtacheo. The bridegroom ſits at table with the ſvati; but in all that day, conſecrated to the matrimonial union, he muſt neither unlooſen or cut any thing whatever. The knum carves his meat, and cuts his bread. It is the domachin's buſineſs to give the toaſts; and the ſtari-ſvat is the firſt who pledges him. Generally the bukkara, a very large wooden cup, goes round, firſt to the ſaint protector of the family; next to the proſperity of the holy faith; and ſometimes to a name the moſt ſublime and venerable. The moſt extravagant abundance reigns at theſe feaſts; and each of the ſvati contributes, by ſending a ſhare of proviſions. The dinner begins with fruit and cheeſe; and the ſoup comes laſt, juſt contrary to our cuſtom. All ſorts of domeſtic fowls, kid, lamb, and ſometimes veniſon, are heaped in prodigal quantities upon their tables; but very rarely a Morlacco eats veal, and perhaps never, unleſs he has been perſuaded to do it out of his own country. This abhorrence to calves fleſh is very ancient among the Morlacchi. St Jerom, againſt Jovinian, takes notice of it; and Tomeo Marnavich, a Boſnian writer, who lived in the beginning of the laſt age, ſays, that the Dalmatians, uncorrupted by the vices of ſtrangers, abſtained from eating calves-fleſh, as an unclean food, even to his days. The women-relations, if they are invited, never dine at table with the men, it being an eſtabliſhed cuſtom for them to dine by themſelves. After dinner, they paſs the reſt of the day in dancing, ſinging ancient ſongs, and in games of dexterity, or of wit and fancy; and in the evening, at a convenient hour after ſupper, the three ritual healths having firſt gone round, the knum accompanies the bridegroom to the matrimonial apartment, which commonly is the cellar or the ſtable, whither the bride is alſo conducted by the diveri and the ſtacheo; but the three laſt are obliged to retire, and the knum remains alone with the new-married couple. If there happens to be any bed prepared better than ſtraw, he leads them to it; and having untied the bride's girdle, he cauſes them both to undreſs each other reciprocally. It is not long ſince the knum was obliged to undreſs the bride entirely; but that cuſtom is now out of uſe; and, inſtead of it, he has the privilege of kiſſing her as often as he pleaſes, wherever he meets her; which privilege may poſſibly be agreeable for the firſt months, but muſt ſoon become very diſguſtful. When they are both undreſſed, the knum retires, and ſtands liſtening at the door, if there be a door. It is his buſineſs to announce the conſummation of the marriage, which he does by diſcharging a piſtol, and is anſwered by many of the company. The next day, the bride, without her veil and virginal cap, dines at table with the ſvati, and is forced to hear the coarſe equivocal jeſts of her indelicate, and ſometimes intoxicated, company. Morlachia.

Theſe nuptial-feaſts, called *ſdrave* by the ancient Huns, are by our Morlacchi called *ſdravize*, from whence our Italian word *ſtravizzo* is undoubtedly derived. They continue three, ſix, eight, or more days, according to the ability or prodigal diſpoſition of the family where they are held. The new-married wife gets no inconſiderable profit in theſe days of joy. And it uſually amounts to much more than all the portion ſhe brings with her, which often conſiſts of nothing but her own cloaths, and perhaps a cow; nay, it happens ſometimes that the parents, inſtead of giving money with their daughter, get ſomething from the bridegroom by way of price. The bride carries water every morning, to waſh the hands of her gueſts, as long as the feaſting laſts; and each of them throws a ſmall piece of money into the baſon, after performing that function, which is a very rare one among them excepting on ſuch occaſions. The brides are alſo permitted to raiſe other little contributions among the ſvati, by hiding their ſhoes, caps, knives, or ſome other neceſſary part of their equipage, which they are obliged to ranſom by a piece of money, according as the company rates it. And, beſides all theſe voluntary or extorted contributions already mentioned, each gueſt muſt give ſome preſent to the new married wife at taking leave the laſt day of the ſdravize; and then ſhe alſo diſtributes ſome trifles in return, which commonly conſiſt in ſhirts, caps, handkerchiefs, and ſuch like.

The nuptial-rites are almoſt preciſely the ſame thro' all the vaſt country inhabited by the Morlacchi; and thoſe in uſe among the peaſants and common people of the ſea-coaſt of Dalmatia, Iſtria, and the iſlands, differ

Morlacchi. differ but little from them. Yet among these particular varieties, there is one of the island Zlarine, near Sebenico, remarkable enough; for there the starisvat (who may naturally be supposed drunk at that hour) must, at one blow, with his naked broad sword, strike the bride's crown of flowers off her head, when she is ready to go to bed. And in the island of Pago, in the village of Novoglia, (probably the Gissa of ancient geographers), there is a custom more comical, and less dangerous, but equally savage and brutal. After the marriage-contract is settled, and the bridegroom comes to conduct his bride to church; her father or mother, in delivering her over to him, makes an exaggerated enumeration of her ill qualities: "Know, since thou wilt have her, that she is good for nothing, ill-natured, obstinate, &c." On which the bridegroom, affecting an angry look, turns to the young woman, with an, "Ah! since it is so, I will teach you to behave better;" and at the same time regales her with a blow or a kick, or some piece of similar gallantry, which is by no means figurative. And it seems in general, that the Morlack women, and perhaps the greatest part of the Dalmatians, the inhabitants of the cities excepted, do not dislike a beating, either from their husbands or lovers.

In the neighbourhood of Dernish, the women are obliged, during the first year after marriage, to kiss all their national acquaintances who come to the house; but after the first year they are dispensed from that compliment; and indeed they become so intolerably nasty, that they are no longer fit to practise it. Perhaps the mortifying manner in which they are treated by their husbands and relations, is, at the same time, both the cause and effect of this shameful neglect of their persons. When a Morlack husband mentions his wife, he always premises, by your leave, or begging your pardon. And when the husband has a bedstead, the wife must sleep on the floor near it. Our author often lodged in Morlack houses, and observed that the female sex is universally treated with contempt: it is true, that the women are by no means amiable in that country; they even deform and spoil the gifts of nature.

The pregnancy and births of those women would be thought very extraordinary among us, where the ladies suffer so much, notwithstanding all the care and circumspection used before and after labour. On the contrary, a Morlack woman neither changes her food nor interrupts her daily fatigue, on account of her pregnancy; and is frequently delivered in the fields, or on the road, by herself; and takes the infant, washes it in the first water she finds, carries it home, and returns the day after to her usual labour, or to feed her flock.

The little creatures, thus carelessly treated in their tenderest moments, are afterwards wrapt in miserable rags, where they remain three or four months, under the same ungentle management; and when that term is elapsed, they are set at liberty, and left to crawl about the cottage and before the door, till they learn to walk upright by themselves; and at the same time acquire that singular degree of strength and health with which the Morlacchi are endowed, and are able, without the least inconvenience, to expose their naked breasts to the severest frost and snow. The infants are allowed to suck their mother's milk while she has any, or till she is with child again; and if that should not happen for three, four, or six years, they continue all that time to receive nourishment from the breast. The prodigious length of the breasts of the Morlacchian women is somewhat extraordinary; for it is very certain, that they can give the teat to their children over their shoulders, or under their arms. They let the boys run about, without breeches, in a shirt that reaches only to the knee, till the age of 13 or 14, following the custom of Bossina, subject to the Porte, where no haraz or capitation-tax is paid for the boys till they wear breeches, they being considered before that time as children, not capable of labouring, or of earning their bread. On the occasion of births, and especially of the first, all the relations and friends send presents of eatables to the woman in childbed, or rather to the woman delivered; and the family makes a supper of all those presents together. The women do not enter the church till 40 days after child-birth.

The Morlacchi pass their youth in the woods, attending their flocks and herds, and in that life of quiet and leisure they often become dexterous in carving with a simple knife; they make wooden cups, and whistles adorned with fanciful basse-reliefs, which are not void of merit, and at least shew the genius of the people.

Morley. MORLEY (George), bishop of Winchester, was the son of Francis Morley, Esq; and was born at London in 1597. He was educated at Christ-church, Oxford, of which he had the canonry in 1641, and the next year was made doctor of divinity. He had also several church-preferments, of which he was deprived by the parliament visitors in the beginning of the year 1648. After this, king Charles I. sent for him to assist at the treaty of the Isle of Wight. After the king's death he attended the lord Capel at his execution, and then retired to Charles II. at the Hague, on whom he constantly waited till his majesty went to Scotland, when he retired to Antwerp, where he read the service of the church of England, as he afterwards did at Breda. At the Restoration he was first made dean of Christ-church, and in 1660 was consecrated bishop of Worcester, and soon after was made dean of the royal chapel. In 1662 he was translated to the bishopric of Winchester, when he bestowed considerable sums on that see, in repairing Farnham-castle and his palace at Westminster, and in purchasing Winchester-house at Chelsea. He died at Farnham-castle in 1684. He was a Calvinist, and before the wars was thought a friend to the Puritans; but after his promotion, he took care to free himself from all suspicions of that kind. He was a pious and charitable man, of a very exemplary life, but extremely passionate. He published, 1. *Epistola apologetica et parænetica ad theologum quendam Belgam scripta*, in 4to. 2. The sum of a short conference between Father Darcey a Jesuit, and Dr Morley at Brussels. 3. An argument drawn from the evidence and certainty of sense against the doctrine of Transubstantiation. 4. A letter to Anne duchess of York. 5. Several sermons, and other pieces.

Mornay. MORNAY (Philip de), lord of Plessis-Marly, governor of Saumur, and one of the best Protestant generals of France, was born of a noble family at Buhy in

in 1549. He became well ſkilled in polite literature, divinity, and the learned languages. Having embraced the Proteſtant religion, he travelled to Italy, Germany, the Netherlands, and to England; and at length engaged himſelf in the intereſt of the king of Navarre, who was afterwards Henry the Great. That prince relied greatly on his judgment, and in 1590 made him counſellor of ſtate. De Pleſſis performed the moſt important ſervices for him, and was one of the lords who contributed moſt to his aſcending the throne. He was in a manner the head and ſoul of the Proteſtants: he had their entire confidence, and acquired great reputation amongſt them on account of his learning, valour, and probity; which occaſioned his being called the *Pope of the Huguenots*. He oppoſed king Henry IV.'s embracing the Romiſh religion to the utmoſt of his power; and ſoon after that event retired from court, and laboured at his famous work on the Euchariſt. He continued to ſupport the Calviniſts party by his writings; and Lewis XIII. taking from him the government of Saumur in 1621, he retired to his barony at Forét-ſur-Seure in Poitou, where he died in 1623, aged 74. He alſo wrote, 1. A treatiſe on the truth of the Chriſtian religion. 2. The myſtery of iniquity; and other works.

MORNING, the beginning of the day, the firſt appearance of light, or the time from midnight till noon.

MOROCCO, an empire of Africa, comprehending a conſiderable part of the ancient Mauritania, is bounded on the weſt by the Atlantic Ocean; on the eaſt by the river Mulvya, which ſeparates it from Algiers; on the north by the Mediterranean; and on the ſouth by mount Atlas, or rather by the river Sus, which divides it from the kingdom of Tafilet. Its greateſt length is from the north-eaſt to the ſouth-weſt, amounting to above 590 miles; its breadth is not above 260 where broadeſt, and in the moſt narrow places is not above half that breadth.

The ancient hiſtory of Morocco hath been already given under the article MAURITANIA. It continued under the dominion of the Romans upwards of 400 years. On the decline of that empire it fell under the Goths, who held it till about the year 600, when the Goths were driven out by the Vandals, the Vandals by the Greeks, and they in their turn by the Saracens, who conquered not only this empire, but we may ſay the whole continent of Africa; at leaſt their religion, one way or other, is to be found in all parts of it. The Saracen empire did not continue long united under one head, and many princes ſet up for themſelves in Africa as well as elſewhere, through whoſe diſſentions the Almoravides were at length raiſed to the ſovereignty, as related under the article ALGIERS, n° 2. Yuſef, or Joſeph, the ſecond monarch of that line, built the city of Morocco, conquered the kingdom of Fez, and the Mooriſh dominions in Spain; all which were loſt by his grandſon Abu Hali, who was defeated and killed by the Spaniards. On this prince's death the crown paſſed to the Mohedians, or Almohedes, with whom it had not continued above three generations, when Mohammed the ſon of Al Manſur loſt the famous battle of Sierra Morena, in which 200,000 Moors were ſlain, and in conſequence of which Alphonſo X. retook a great many of the Mooriſh conqueſts immediately after.

Mohammed died ſoon after this diſgrace, and left ſeveral ſons, between whom a civil war enſued, during which the viceroys of Fez, Tunis, and Tremeſen, found means to eſtabliſh themſelves as independent princes. At length one of the princes of the royal blood of Tremeſen having defeated the Almohedes, made himſelf maſter of the kingdoms of Morocco and Fez, and entailed them on his own family. In a ſhort time, however, this family was expelled by the Merini, the Merini by the Oatazes, and theſe by the Sharifs of Haſcen, who have kept the government ever ſince.

This happened about the year 1516; and ſince that time the hiſtory of the empire affords nothing remarkable. What we have under that name is indeed nothing elſe than a catalogue of the enormous vices and and exceſſes of the emperors and people. Nothing indeed can be conceived more unjuſt and deſpotic than the government of Morocco, and nothing more degenerate than the characters of the people. The emperor is allowed to have not only an uncontrolable power over the lives and fortunes of his ſubjects, but in a great meaſure over their conſciences, ſuch as they are; in as much as he is the only perſon who, as the ſucceſſor of the prophet, hath a right to interpret the Koran; and appoints all the judges under him, of whom thoſe of Morocco and Fez are the chief, whoſe buſineſs it is to explain and diſpenſe all matters relating to their religion; and, being his creatures and dependents, dare not ſteer otherwiſe than as he directs. Whenever therefore the laws are enacted by him, and proclaimed by his governors in all the provinces, as is commonly done, that none may plead ignorance, they are everywhere received with an implicit and religious ſubmiſſion. On the other hand, the ſubjects are bred up with a notion, that thoſe who die in the execution of his command are entitled to an immediate admittance into paradiſe, and thoſe who have the honour to die by his hand to a ſtill greater degree of happineſs in it. After this we need not wonder at finding ſo much cruelty, oppreſſion, and tyranny on the one ſide, and ſo much ſubmiſſion, paſſiveneſs, and miſery on the other.

This latter, however, extends no farther than the Moors: for as to the Arabs, the ſubjection and tribute they pay to thoſe tyrants was always involuntary, and altogether forced; and as for the negroes, their zeal and attachment is owing merely to the great ſway and power which they have gained in the government, both on account of their being better ſoldiers than the Moors, and from a particular regard which Muley Iſhmael a late emperor had for them on account of his mother being a negro; ſo that, being now grown in a manner too ſtrong to be ſuppreſſed, their loyalty and affection to thoſe monarchs, whom they ſtrive to imitate in all their vices, muſt be ſuppoſed to riſe and fall according to the favour and encouragement they receive from them. And they are now the only ones to whom thoſe tyrants entruſt their perſons, their treaſure, and their concubines; whom they raiſe to the higheſt poſts of authority and truſt; and whom they ſuffer, not to ſay encourage by their

Morocco. their own example, to tyrannize and oppress their native, as well as their most faithful and submissive subjects.

These negroes, ever since their adhering so closely to Muley Ishmael, have been in high request with his successors, and make the main branch of the soldiery both of horse and foot. They are brought so young out of Guinea, that they quickly lose the memory of it; and having no relations or friends, nor dependence but on the emperor's favour, are the more ready to obey his orders in all things. They are at first brought up to be foot-soldiers; and after so many years service in it, or sooner if their behaviour deserve it, are advanced to the cavalry, which is a great honour in that country. They are taught little else except the exercise of arms, and to obey the emperor's orders; and, by the readiest compliance with his views, politics, and inclination, advance themselves to the highest posts under him.

But we shall perhaps find less reason to wonder at this connivance, if we consider, that, sooner or later, all the extortions of those blood-suckers come in course into their own treasury, either by the heavy fines they impose upon them upon any complaint preferred against them, or upon any other, whether real or pretended, mal-administrations, or by seizing on all their ill-gotten wealth at their deaths. For the emperors here have found means to establish another branch of despotism, which renders them still more powerful and formidable to their subjects; viz. their making themselves their sole heirs, and, in virtue of that, seizing upon all their effects, and making only such provision for their families as they think proper; and often, on some frivolous pretence, leaving them destitute of any, according to the liking or dislike they bear to the deceased: so that, upon the whole, they are the only makers, judges, and interpreters, and in many instances likewise the executioners, of their own laws, which have no other limits than their own arbitrary will. To preserve, however, some specious shew or shadow of justice, they allow their mufti a kind of superiority in spirituals, and a sort of liberty to the meanest subject to summon them before his tribunal. But the danger which such an atttempt would bring upon a plaintiff, perhaps no less than death and destruction, is of itself sufficient to deter any man from it; especially considering the little probability there is that the judges of it would run the risk of declaring themselves against a monarch whose creatures they are, and on whom their lives and fortunes so absolutely depend.

The titles which the emperors of Morocco assume, are those of *Most glorious, mighty, and noble emperor of Afric, king of Fez and Morocco, Taphilet, Suz, Darha, and all the Algarbe, and its territories in Afric; grand Sharif* (or, as others write it, *Xarif*, that is, "successor, or vicegerent,") *of the great prophet Mohammed, &c.*

The judges or magistrates that act immediately under him, are either spiritual or temporal, or rather ecclesiastic and military. The mufti and the kadis are judges of all religious and civil affairs; and the bashas, governors, alcaides, and other military officers, of those that concern the state or the army. All of them the most obsequious creatures and slaves of their prince, and no less the rapacious tyrants of his subjects, and from whom neither justice nor favour can be obtained but by mere dint of money, and extortionate bribery, from the highest to the lowest. Neither can it indeed be otherwise in such an arbitrary government, where the highest posts must not only be bought of the prince at a most extravagant price, and kept only by as exorbitant a tribute, which is yearly paid to him, but where no one is sure to continue longer than he can bribe some of the courtiers to insinuate to the monarch that he pays to the utmost of his power, and much beyond what was expected from him. Add to this, that those bashas, governors, &c. are obliged to keep their agents and spies in constant pay at court, to prevent their being supplanted by higher bidders, slanderers, or other artful underminers.

From what hath been said under this head, it may be reasonably concluded that this branch of the imperial revenue must be very considerable, though there is no possibility to make any other conjecture of its real amount, than that it must be an immense one. Another considerable branch is the piratical trade, which brings the greater income into his treasury, as he is not at any expence either for fitting of corsair vessels out, or maintaining their men: and yet hath the tenth of all the cargo, and of all the captives; besides which, he appropriates to himself all the rest of them, by paying the captors 50 crowns *per* head; by which means he engrosses all the slaves to his own service and advantage. This article is indeed a very considerable addition to his revenue, not only as he sells their ransom at a very high rate, but likewise as he hath the profit of all their labour, without allowing them any other maintenance than a little bread and oil, nor any other assistance when sick than what medicines a Spanish convent, which he tolerates there, gives them gratis; and which, nevertheless, is forced to pay him an annual present for that toleration, besides furnishing the court with medicines, and the slaves with lodging and diet when they are not able to work. Another branch of his revenue consists in the tenth part of all cattle, corn, fruits, honey, wax, hides, rice, and other products of the earth, which is exacted of the Arabs and Berebers, as well as of the natives; and these are levied, or rather farmed, by the bashas, governors, alcaides, &c. with all possible severity. The Jews and Christians likewise pay an income or capitation, the former of six crowns *per* head on all males from 15 years and upwards, besides other arbitrary imposts, fines, &c. That on the Christians, for the liberty of trading in his dominions, rises and falls according to their number, and the commerce they drive; but which, whatever it may bring yearly into his coffers, is yet detrimental to trade in general, seeing it discourages great numbers from settling there, notwithstanding the artful invitations which the emperors and their ministers make use of to invite them to it; for, besides those arbitrary exactions, there is still another great hardship attending them, viz. that they cannot leave the country without forfeiting all their debts and effects to the crown. The duties on all imports and exports is another branch of his income, the amount of which, *communibus annis*, no author hath yet given us any account of; only consul Hatfield hath computed the whole yearly revenue,

venue, including ordinaries and extraordinaries, to amount to 500 quintals of ſilver, each quintal, or 100 lb. weight, valued at ſomewhat above 330l. Sterling; ſo that the whole amounts to no more, according to him, than 165,000l.; a ſmall revenue indeed for ſo large an empire, if the calculation may be depended upon. But St Olan, though he doth not pretend ſo much as to gueſs at the yearly amount of it, doth in general repreſent it as ſo conſiderable, that Muley Iſhmael was reckoned to have amaſſed out of it a treaſure in gold and ſilver of about 50 effective millions; but whether of crowns or livres he doth not tell us, nor how he came by his knowledge of it; becauſe that politic prince, even by his own confeſſion, not only cauſed all his riches to be buried in ſundry places under-ground, his gold and ſilver to be melted into great lumps, and laid in the ſame privacy underground, but likewiſe all thoſe whom he entruſted with the ſecret to be as privately murdered. However that be, we ſhall, upon the whole, have the leſs cauſe to wonder at theſe exorbitant exactions which he extorts from Chriſtian princes and ſtates, whenever they are obliged either to ſeek his alliance, or to obtain ſome redreſs in favour of their trading ſubjects; much leſs at the ſhameful delays, inſults, extortions, indignities, and injuſtice, which their ambaſſadors muſt be content to put up with, to obtain the leaſt favour from their rapacious miniſters.

The air of this country, though hot and dry, is pleaſant and healthy, the winds from the ſea and mount Atlas refreſhing the inhabitants in the hotteſt ſeaſon.

As to the ſoil, it is neither ſo mountainous, ſandy, or barren, as many other parts of Africa; but produces, or would produce if duly cultivated, vaſt quantities of corn, wine, and oil. No country affords better wheat, barley, or rice: both the French and Spaniards fetch theſe from the Barbary coaſt, when they have a ſcarcity at home; and our garriſons of Gibraltar and Port-Mahon are often ſupplied with proviſions from thence. The plains of Fez and Morocco are well planted with olives: and there are no better grapes for making wine in the world, as the Jews at Tetuan experience; though the cultivation of vines is not encouraged among the Mahommedans, in conſequence of the precept in the Koran, forbidding the drinking of wine. Here are alſo other fruits, as dates, figs, raiſins, almonds, apples, pears, cherries, plums, citrons, lemons, oranges, pomegranates, with plenty of roots and herbs, hemp, flax, ſugar, honey, and wax: but they have not many foreſt-trees, and ſcarce any good timber; poſſibly their ſoil is not proper for timber, or they take no care to preſerve it, having little occaſion for any.

The animals of this part of Africa, whether wild or tame, are much the ſame we meet with to the ſouthward; except the elk, the elephant, and the rhinoceros, which no travellers pretend to meet with in the empire of Morocco: and as they want theſe, ſo they have ſome others not to be found in the ſouth of Africa, particularly camels, dromedaries, and that fine breed of horſes called *barbs*, which for their beauty and ſwiftneſs can ſcarce be paralleled in the world. Nor are their horſes to be admired only for their beauty and ſpeed, but their uſe in war, being extremely ready to obey their riders upon the leaſt ſign, in charging, wheeling, or retiring; ſo that the trooper has his hands very much at liberty, and can make the beſt uſe of his arms.

As to mountains, the chief are that chain which goes under the name of *Mount Atlas*, and runs the whole length of Barbary from eaſt to weſt, paſſing through Morocco, and abutting upon that ocean which ſeparates the eaſtern from the weſtern continent, and is from this mountain called the *Atlantic Ocean*. This mountain, as the poets feigned, ſuſtained the univerſe; hence we ſee Atlas repreſented with the world upon his ſhoulders, and deſcriptions of the globe or ſets of maps dignified with the name of *Atlas*. Dr Shaw, however, aſſures us, that this chain cannot ſtand in competition either with the Alps or Appennines for height. Near the Straits ſtands the mountain anciently called *Abyla*, and now, if we are not miſtaken, by our countrymen ſtyled the *Apes-hill*.

The principal rivers, beſides the Malva or Mulvia above-mentioned, which riſes in the deſarts, and running from ſouth to north divides Morocco from the kingdom of Algiers, are the Suz, Ommirabih, Rabbatta, Larache, Darodt, Sebon, Gueron, and Tenſift, which riſe in Mount Atlas, and fall into the Atlantic Ocean.

The chief capes are Cape Threeforks on the Miditerranean, Cape Spartel at the enterance of the ſtraits, Cape Cantin, Cape None, and Cape Rajador, on the Atlantic Ocean.

Of the bays the moſt conſiderable are, the bay of Tetuan in the Mediterranean, and the bay of Tangier in the ſtraits of Gibraltar.

There are ſome mines of very fine copper in this empire; but if there are any of gold and ſilver, as ſome writers tell us, they have never been opened, as far as we can find.

The traffic of the empire by land is either with Arabia or Negroland: to Mecca they ſend caravans, conſiſting of ſeveral thouſand camels, horſes, and mules, twice every year, partly for traffic, and partly upon a religious account; for numbers of pilgrims take that opportunity of paying their devotions to their great prophet. The goods they carry to the eaſt are woollen manufactures, very fine Morocco ſkins, indigo, cochineal, and oſtrich feathers; and they bring back from thence, ſilk, muſlins, and drugs. By their caravans to Negroland, they ſend ſalt, ſilk, and woollen manufactures, and bring back gold and ivory in return, but chiefly negroes: for from hence it is that their emperor chiefly recruits his black cavalry, though there are alſo great numbers born in the country; for they bring thoſe of both ſexes very young from Negroland, the females for breeders, and the males for ſoldiers. As they grow up, they firſt carry a muſket, and ſerve on foot, and after ſome time are preferred to be cavaliers: and as they have no other hopes or dependence but the favour of the emperor, they prove much the moſt dutiful and obſequious of all his ſubjects, and indeed ſupport his tyranny over the reſt. The caravans always go ſtrong enough to defend themſelves againſt the wild Arabs in the deſarts of Africa and Aſia; though, notwithſtanding all their vigilance, ſome of the ſtragglers and baggage often

fall

Morocco. fall into their hands: they are alfo forced to load one half of their camels with water, to prevent their perifhing with drought and thirft in thofe inhofpitable defarts. And there is ftill a more dangerous enemy, and that is the fand itfelf: when the winds rife, the caravan is perfectly blinded with duft; and there have been inftances both in Africa and Afia, where whole caravans, and even armies, have been buried alive in the fands. There is no doubt alfo, but both men and cattle are fometimes furprifed by wild beafts, as well as robbers, in thofe vaft defarts; the hot winds alfo, blowing over a long tract of burning fand, are equal almoft to the heat of an oven, and deftroy abundance of merchants and pilgrims. If it was not for devotion, and in expectation of very great gains, no man would undertake a journey in thefe defarts; great are the hazards and fatigues they muft of neceffity undergo; but thofe that go to Mecca affure themfelves of paradife if they die, and have uncommon honours paid them at home if they furvive. People crowd to be taken into the eaftern caravans; and the gold that is found in the fouth, make them no lefs eager to undertake that journey.

The natives have hardly any trading veffels, but are feldom without fome corfairs. Thefe, and European merchant-fhips, bring them whatever they want from abroad; as linen and woollen cloth, ftuffs, iron wrought and unwrought, arms, gunpowder, lead, and the like: for which they take in return, copper, wax, hides, Morocco leather, wool, (which is very fine) gums, foap, dates, almonds, and other fruits.

The coins of this empire are a fluce, a blanquil, and ducat. The fluce is a fmall copper coin, twenty whereof make a blanquil, of the value of two-pence Sterling. The blanquil is of filver, and the ducat of gold, not unlike that of Hungary, and worth about nine fhillings. Both thefe pieces are fo liable to be clipped and filed by the Jews, that the Moors always carry fcales in their pockets to weigh them; and when they are found to be much diminifhed in their weight, they are recoined by the Jews, who are mafters of the mint, by which they gain a confiderable profit; as they do alfo by exchanging the light pieces for thofe that are full weight. Merchants accouuts are kept in ounces, ten of which make a ducat; but in payments to the government, it is faid they will reckon feventeen one-half for a ducat.

With refpect to religion, the inhabitants of Morocco are Mohammedans, of the fect of Ali; and have a mufti, or high-prieft, who is alfo the fupreme civil magiftrate, and the laft refort in all caufes ecclefiaftical and civil. They have a great veneration for their hermits, and for idiots and madmen; as well as for thofe who by their tricks have got the reputation of wizzards: all whom they look upon as infpired perfons, and not only honour as faints while they live, but build tombs and chapels over them when dead; which places are not only devoutly vifi ed by their devotees far and near, but are efteemed inviolable fanctuaries for all forts of criminals, except in cafes of treafon.

Notwithftanding the natives are zealous Mohammedans, they allow foreigners the free and open profeffion of their religion, and their very flaves have their priefts and chapels in the capital city, though it muft be owned that the Chriftian flaves are here treated with the utmoft cruelty. Here, as in all other Mohammedan countries, the alcoran and their comments upon it are their only written laws; and though in fome inftances their cadis, and other civil magiftrates, are controlled by the arbitrary determinations of their princes, bafhaws, generals, and military officers, yet the latter have generally a very great deference and regard for their laws. Murder, theft, and adultery, are commonly punifhed with death: and their punifhments for other crimes, particularly thofe againft the ftate, are very cruel; as impaling, dragging the prifoner through the ftreets at a mule's heels, till all his flefh is torn off; throwing him from a high tower upon iron hooks; hanging him upon hooks till he die; crucifying him againft a wall; and, indeed, the punifhment and condemnation of criminals is in a manner arbitrary. The emperor, or his bafhaws, frequently turn executioners; fhoot the offender, or cut him to pieces with their own hands, or command others to do it in their prefence. Morocco.

In regard to the character of the Moors, they are faid to be a covetous inhofpitable people, intent upon nothing but heaping up riches, to obtain which they will be guilty of the meaneft things, and ftick at no manner of fraud. The Arabs alfo, who are almoft as numerous as the Moors, have always had the character of a pilfering generation. The people who inhabit the hills, and who have the leaft to do with the court and with traffic, are much the honefteft people among them, and ftill retain a good fhare of liberty, the government ufing them rather as allies than fubjects, left they fhould entirely difown their authority. The Moors, however, with all their bad qualities, are obferved to be very dutiful to their parents, their princes, and fuperiors. A plurality of wives is allowed here, as in other Mohammedan countries; nor do they confine themfelves to women, but keep boys, as they do in Turkey. The woman who commits adultery is punifhed with death; but it is not difficult for them to obtain a divorce, if ill ufed.

The dead are carried to the grave in their ufual drefs, the priefts finging before them, *La illa All illa, Mahomet Refoul Alla*; i. e. God is a great God, and Mahomet his prophet.

The Moors, or natives of the country, are of much the fame complexion as the Spaniards on the oppofite fhore; but fuch multitudes of negroes have been brought from Guinea, that you fee almoft as many black as white people, efpecially about Mequinez, where the court refides. The habit of a Moor is a linen frock or fhirt next his fkin, a veft of filk or cloth tied with a fafh, a pair of drawers, a loofe coat, his arms bare to the elbow, as well as his legs, fandals or flippers on his feet, and fometimes people of condition wear bufkins: they fhave their heads, and wear a turban, which is never pulled off before their fuperiors, or in their temples; they exprefs their reverence both to God and man by pulling off their flippers, which they leave at the door of the mofque or palace; and, when they attend their prince in the city, they run bare-foot after him, if the ftreets are ever fo dirty. Their turbans are of fine filk, or fine linen. The habit of the women is not very different from

from that of the men, except that they wear a fine linen cloth or caul on their heads, inftead of a turban, and their drawers are much larger and longer than the mens. The women alfo, when they go abroad, have a linen cloth over their faces, with holes in it for their eyes, like a mafk.

Morocco, the capital city of the kingdom of Morocco, in Barbary; feated in a very large plain, 250 miles fouth by weft of Fez, 125 north-weft of Suez, and 15 from Mount Atlas. It was furrounded by a ftrong wall, fortified with towers and fome bulwarks, and encompaffed with deep ditches. The number of houfes were reckoned formerly to be 100,000, all with flat roofs; but they are now greatly diminifhed, infomuch that the greateft part of the city is unpeopled. The irruptions and robberies of the Arabs hinder them from cultivating the lands about it, infomuch that there is nothing but vines, date-trees, and fome other fruits. There were three temples or mofques in this place, of a prodigious fize; and the emperor's palace was fo large, and took up fo much ground, that it refembled a fmall city. A late traveller affirms, that the inhabitants now are not above 25,000, and that the houfes go to ruin every day, without being rebuilt. This may happen partly from the removal of the court, which is now at Mequinez. W. Long. 6. 45. N. Lat. 30. 32.

Morocco, or *Turkey-leather*. See Leather.

MOROCHTHUS, in natural hiftory, an indurated clay called by us *French chalk*; ferving taylors and others to mark with. The ancients efteemed it as an aftringent, prefcribing it in the colic, hæmorrhages, and other fluxes.

MORON, a town of Spain, in Andalufia, feated in a pleafant fertile plain, and in the neighbourhood is a mine of precious ftones. It is 30 miles fouth-eaft of Seville. W. Long. 5. 20. N. Lat. 37. 0.

MORPETH, a handfome town of Northumberland, which fends two members to parliament. The moft remarkable particular concerning it is a ftory of its being reduced to afhes by its own inhabitants on the approach of king John in 1215, out of pure hatred to their monarch, that he might find no fhelter there.

MORPHEUS, in fabulous hiftory, the god of fleep, or, according to others, one of the minifters of Somnus. He caufed fleepinefs, and reprefented the forms of dreams. Ovid ftyles him the kindeft of the deities; and he is ufually defcribed in a recumbent pofture, and crowned with poppies.

MORSE, in zoology. See Trichecus.

MORTALITY, or *Bills of* Mortality, properly denote lifts of the perfons who die in any place. See Annuities.

Brief *of* MORTANCESTRY, in Scots law; anciently the ground of an action at the inftance of an heir, in the fpecial cafe where he had been excluded from the poffeffion of his anceftor's eftate by the fuperior, or other perfon pretending right.

MORTAR, a preparation of lime and fand mixed with water, which ferves as a cement, and is ufed by mafons and bricklayers in building walls of ftone and brick.

Under the article Cement, we have already given the theory of mortar, as delivered by Mr Anderfon; which hath now received a farther confirmation by a recent difcovery, that if the lime is flaked, and the mortar made up with lime-water inftead of common water, the mortar will be much better. The reafon of this is, that in common water, efpecially fuch as is drawn from wells, there is always a confiderable quantity of fixed air, which, mingling with the mortar previous to its being ufed, fpoils it by reducing the quicklime in part to an inert calcareous earth like chalk; but when it is built up in a perfectly cauftic ftate, it attracts the air fo flowly, that it hardens into a kind of ftony matter as hard as was the rock from whence the limeftone was taken.

Mortar, a chemical inftrument very ufeful for the divifion of bodies, partly by percuffion, and partly by grinding. Mortars have the form of an inverted bell. The matter intended to be pounded is to be put into them, and there it is to be ftruck and bruifed by a long inftrument called a *peftle*. The motion given to the peftle ought to vary according to the nature of the fubftances to be pounded. Thofe which are eafily broken, or which are apt to fly out of the mortar, or which are hardened by the ftroke of the peftle, require that this inftrument fhould be moved circularly, rather by grinding or bruifing, than by ftriking. Thofe fubftances which are foftened by the heat occafioned by rubbing and percuffion, require to be pounded very flowly. Laftly, thofe which are very hard, and which are not capable of being foftened, are eafily pounded by repeated ftrokes of the peftle. They require no bruifing but when they are brought to a certain degree of finenefs. But thefe things are better learnt by habit and practice than by any directions.

As mortars are inftruments which are conftantly ufed in chemiftry, they ought to be kept of all fizes and materials; as of marble, copper, glafs, iron, grittftone, and agate. The nature of the fubftance to be pounded determines the choice of the kind of mortar. The hardnefs and diffolving power of that fubftance are particularly to be attended to. As copper is a foft metal, foluble by almoft all menftruums, and hurtful to health, good artifts have fome time ago profcribed the ufe of this metal.

One of the principal inconveniencies of pulverifation in a mortar proceeds from the fine powder which rifes abundantly from fome fubftances during the operation. If thefe fubftances be precious, the lofs will be confiderable; and if they be injurious to health, they may hurt the operator. Thefe inconveniencies may be remedied, either by covering the mortar with a fkin, in the middle of which is a hole, thro' which the peftle paffes; or by moiftening the matter with a little water, when this addition does not injure it; or, laftly, by covering the mouth and nofe of the operator with a fine cloth, to exclude this powder. Some fubftances, as corrofive fublimate, arfenic, calxes of lead, cantharides, euphorbium, &c. are fo noxious, that all thefe precautions ought to be ufed, particularly when a large quantity of them is pounded.

Large mortars ought to be fixed upon a block of wood, fo high, that the mortar fhall be level with the middle of the operator. When the peftle is large and heavy, it ought to be fufpended by a cord or chain fixed to a moveable pole, placed horizontally above the mortar: this pole confiderably relieves the

the operator, becaufe its elafticity affifts the raifing of the peftle.

MORTAR-PIECE. See GUN, par. ult. GUNNERY, n° 50, 52, 55. and Plate CXLI. and CXLIII. fig. 20.

MORTGAGE, in law, (*mortuum vadium*, or dead-pledge,) is where a man borrows of another a fpecific fum (*e. g.* 200 l.) and grants him an eftate in fee, on condition that if he, the mortgagor, fhall pay the mortgagee the faid fum of 200 l. on a certain day mentioned in the deed, that then the mortgagor may re-enter on the eftate fo granted in pledge; or, as is now the more ufual way, that the mortgagee fhall reconvey the eftate to the mortgagor: in this cafe the land which is fo put in pledge, is by law, in cafe of nonpayment at the time limited, for ever dead and gone from the mortgagor; and the mortgagee's eftate in the lands is then no longer conditional, but abfolute. But, fo long as it continues conditional, that is, between the time of lending the money, and the time allotted for payment, the mortgagee is called *tenant in mortgage*. But as it was formerly a doubt, whether, by taking fuch eftate in fee, it did not become liable to the wife's dower, and other incumbrances, of the mortgagee, (though that doubt has been long ago over-ruled by our courts of equity), it therefore became ufual to grant only a long term of years, by way of mortgage; with condition to be void on repayment of the mortgage-money: which courfe has been fince continued, principally becaufe on the death of the mortgagee fuch term becomes vefted in his perfonal reprefentatives, who alone are entitled in equity to receive the money lent, of whatever nature the mortgage may happen to be.

As foon as the eftate is created, the mortgagee may immediately enter on the lands; but is liable to be difpoffeffed, upon performance of the condition by payment of the mortgage-money at the day limited. And therefore the ufual way is to agree that the mortgagor fhall hold the land till the day affigned for payment; when, in cafe of failure, whereby the eftate becomes abfolute, the mortgagee may enter upon it and take poffeffion, without any poffibility at law of being afterwards evicted by the mortgagor, to whom the land is now for ever dead. But here again the courts of equity interpofe; and though a mortgage be thus forfeited, and the eftate abfolutely vefted in the mortgagee at the common law, yet they will confider the real value of the tenements compared with the fum borrowed. And if the eftate be of greater value than the fum lent thereon, they will allow the mortgagor at any reafonable time to re-call or redeem his eftate; paying to the mortgagee his principal, intereft, and expenfes: for otherwife, in ftrictnefs of law, an eftate worth 1000 l. might be forfeited for non-payment of 100 l. or a lefs fum. This reafonable advantage, allowed to mortgagors, is called the *equity of redemption*; and this enables a mortgagor to call on the mortgagee, who has poffeffion of his eftate, to deliver it back, and account for the rents and profits received, on payment of his whole debt and intereft; thereby turning the *mortuum* into a kind of *vivum vadium*; (fee VADIUM). But, on the other hand, the mortgagee may either compel the fale of the eftate, in order to get the whole of his money immediately; or elfe call upon the mortgagor to redeem his eftate prefently, or, in default thereof, to be for ever foreclofed from redeeming the fame; that is, to lofe his equity of redemption without poffibility of recall. And alfo, in fome cafes of fraudulent mortgages, the fraudulent mortgagor forfeits all equity of redemption whatfoever. It is not, however, ufual for mortgagees to take poffeffion of the mortgaged eftate, unlefs where the fecurity is precarious, or fmall; or where the mortgagor neglects even the payment of intereft: when the mortgagee is frequently obliged to bring an ejectment, and take the land into his own hands, in the nature of a pledge, or the *pignus* of the Roman law: whereas, while it remains in the hands of the mortgagor, it more refembles their hypotheca, which was where the poffeffion of the thing pledged remained with the debtor. But, by ftatute 7 Geo. II. c. 20. after payment or tender by the mortgagor of principal, intereft, and cofts, the mortgagee can maintain no ejectment; but may be compelled to re-affign his fecurities. In Glanvil's time, when the univerfal method of conveyance was by livery of feifin or corporal tradition of the lands, no gage or pledge of lands was good unlefs poffeffion was alfo delivered to the creditor; *fi non fequatur ipfius vadii traditio, curia domini regis hujufmodi privatas conventiones tueri non folet*: for which the reafon given is, to prevent fubfequent and fraudulent pledges of the fame land; *cum in tali cafu poffit eadem res pluribus aliis creditoribus tum prius tum pofterius invadiari*. And the frauds which have arifen, fince the exchange of thefe public and notorious conveyances for more private and fecret bargains, have well evinced the wifdom of our ancient law.

MORTIER, an enfign of dignity, borne by the chancellor and grand prefidents of the parliament of France. That borne by the chancellor is a piece of cloth of gold, edged and turned up with ermine; and that of the firft prefident is a piece of black velvet edged with a double row of gold lace, while that of the other prefidents is only edged with a fingle row. This they formerly carried on their heads, as they ftill do in grand ceremonies, fuch as the entry of the king; but ordinarily they carry them in the hand.

MORTISE, or MORTOISE, in carpentry, &c. a kind of joint wherein a hole of a certain depth is made in a piece of timber, which is to receive another piece called a *tenon*.

MORTMAIN, or ALIENATION *in Mortmain*, (*in mortua manu*), is an alienation of lands or tenements to any corporation, fole or aggregate, ecclefiaftical or temporal *: but thefe purchafes having been chiefly made by religious houfes, in confequence whereof the lands became perpetually inherent in one dead hand, this hath occafioned the general appellation of *mortmain* to be applied to fuch alienations, and the religious houfes themfelves to be principally confidered in forming the ftatutes of mortmain: in deducing the hiftory of which ftatutes, it will be matter of curiofity to obferve the great addrefs and fubtile contrivance of the ecclefiaftics in eluding from time to time the laws in being, and the zeal with which fucceffive parliaments have purfued them through all their fineffes: how new remedies were ftill the parents of new evafions; till the legiflature at laft, though with difficulty, hath

* See *Corporation*.

Mortmain. hath obtained a decifive victory.

By the common law any man might difpofe of his lands to any other private man at his own difcretion, efpecially when the feodal reftraints of alienation were worn away. Yet in confequence of thefe it was always, and is ftill neceffary, for corporations to have a licence of mortmain from the crown, to enable them to purchafe lands: for as the king is the ultimate lord of every fee, he ought not, unlefs by his own confent, to lofe his privilege of efcheats and other feodal profits, by the vefting of lands in tenants that can never be attainted or die. And fuch licences of mortmain feem to have been neceffary among the Saxons, above 60 years before the Norman conqueft. But, befides this general licence from the king as lord paramount of the kingdom, it was alfo requifite, whenever there was a mefne or intermediate lord between the king and the alienor, to obtain his licence alfo (upon the fame feodal principles) for the alienation of the fpecific land. And if no fuch licence was obtained, the king or other lord might refpectively enter on the lands fo alienated in mortmain, as a forfeiture. The neceffity of this licence from the crown was acknowledged by the conftitutions of Clarendon, in refpect of advowfons, which the monks always greatly coveted, as being the groundwork of fubfequent appropriations. Yet fuch were the influence and ingenuity of the clergy, that (notwithftanding this fundamental principle) we find that the largeft and moft confiderable dotations of religious houfes happened within lefs than two centuries after the conqueft. And (when a licence could not be obtained) their contrivance feems to have been this: That as the forfeiture for fuch alienations accrued in the firft place to the immediate lord of the fee, the tenant who meant to alienate firft conveyed his lands to the religious houfe, and inftantly took them back again to hold as tenant to the monaftery; which kind of inftantaneous feifin was probably held not to occafion any forfeiture: and then, by pretext of fome other forfeiture, furrender, or efcheat, the fociety entered into thofe lands in right of fuch their newly acquired figniory, as immediate lords of the fee. But when thefe donations began to grow numerous, it was obferved that the feodal fervices, ordained for the defence of the kingdom, were every day vifibly withdrawn; that the circulation of landed property from man to man began to ftagnate; and that the lords were curtailed of the fruits of their figniories, their efcheats, wardfhips, reliefs, and the like: and therefore, in order to prevent this, it was ordained by the fecond of king Henry III.'s great charters, and afterwards by that printed in our common ftatute-books, that all fuch attempts fhould be void, and the land forfeited to the lord of the fee.

Blackft. Comment.

But as this prohibition extended only to religious houfes, bifhops and other fole corporations were not included therein; and the aggregate ecclefiaftical bodies (who, Sir Edward Coke obferves, in this were to be commended, that they ever had of their counfel the beft learned men that they could get) found many means to creep out of this ftatute, by buying in lands that were *bona fide* holden of themfelves as lords of the fee, and thereby evading the forfeiture; or by taking long leafes for years, which firft introduced thofe extenfive terms, for a thoufand or more years, which are now fo frequent in conveyances. This produced the ftatute *de religiofis*, 7 Edward I.; which provided, that no perfon, religious or other whatfoever, fhould buy, or fell, or receive, under pretence of a gift, or term of years, or any other title whatfoever, nor fhould by any art or ingenuity appropriate to himfelf any lands or tenements in mortmain; upon pain that the immediate lord of the fee, or, on his default for one year, the lords paramount, and, in default of all of them, the king, might enter thereon as a forfeiture. Mortmain.

This feemed to be a fufficient fecurity againft all alienations in mortmain: but as thefe ftatutes extended only to gifts and conveyances between the parties, the religious houfes now began to fet up a fictitious title to the land, which it was intended they fhould have, and to bring an action to recover it againft the tenant; who, by fraud and collufion, made no defence, and thereby judgment was given for the religious houfe, which then recovered the land by a fentence of law upon a fuppofed prior title. And thus they had the honour of inventing thofe fictitious adjudications of right, which are fince become the great affurance of the kingdom, under the name of *common* RECOVERIES. But upon this the ftatute of Weftminfter the fecond, 13 Edw. I. c. 32. enacted, that in fuch cafes a jury fhall try the true right of the demandants or plaintiffs to the land; and if the religious houfe or corporation be found to have it, they fhall ftill recover feifin; otherwife it fhall be forfeited to the immediate lord of the fee, or elfe to the next lord, and finally to the king, upon the immediate or other lord's default. And the like provifion was made by the fucceeding chapter, in cafe the tenants fet up croffes upon their lands (the badges of knights templars and hofpitallers) in order to protect them from the feodal demands of their lords, by virtue of the privileges of thofe religious and military orders. And fo careful was this provident prince to prevent any future evafions, that when the ftatute of *quia emptores*, 18 Edward I. abolifhed all fub-infeudations, and gave liberty for all men to alienate their lands to be holden of their next immediate lord, a provifo was inferted that this fhould not extend to authorife any kind of alienation in mortmain. And when afterwards the method of obtaining the king's licence by writ of *ad quod damnum* was marked out, by the ftatute 27 Edward I. ft. 2. it was farther provided by ftatute 34 Edward I. ft. 3. that no fuch licence fhould be effectual without the confent of the mefne or intermediate lords.

Yet ftill it was found difficult to fet bounds to ecclefiaftical ingenuity: for when they were driven out of all their former holds, they devifed a new method of conveyance, by which the lands were granted, not to themfelves directly, but to nominal feoffees to the ufe of the religious houfes; thus diftinguifhing between the poffeffion and the ufe, and receiving the actual profits, while the feifin of the land remained in the nominal feoffee; who was held by the courts of equity (then under the direction of the clergy) to be bound in confcience to account to his *ceftuy que ufe* for the rents and emoluments of the eftate. And it is to thefe inventions that our practifers are indebted for the introduction of ufes and trufts, the foundation of modern conveyancing. But, unfortunately for the inventors themfelves, they did not long enjoy

Mortmain. enjoy the advantage of their new device; for the ftatute 15 Richard II. c. 5. enacts, that the lands which had been fo purchafed to ufes fhould be amortifed by licence from the crown, or elfe be fold to private perfons; and that for the future ufes fhall be fubject to the ftatutes of mortmain, and forfeitable like the lands themfelves. And whereas the ftatutes had been eluded by purchafing large tracts of land adjoining to churches, and confecrating them by the name of *church-yards*, fuch fubtile imagination is alfo declared to be within the compafs of the ftatutes of mortmain. And civil or lay corporations, as well as ecclefiaftical, are alfo declared to be within the mifchief, and of courfe within the remedy provided by thofe falutary laws. And, laftly, as during the times of popery lands were frequently given to fuperftitious ufes, though not to any corporate bodies; or were made liable in the hands of heirs and devifees to the charge of obits, chauntries, and the like, which were equally pernicious in a well-governed ftate as actual alienations in mortmain; therefore at the dawn of the Reformation, the ftatute 23 Hen. VIII. c. 10. declares, that all future grants of lands for any of the purpofes aforefaid, if granted for any longer term than 20 years, fhall be void.

But, during all this time, it was in the power of the crown, by granting a licence of mortmain, to remit the forfeiture, fo far as related to its own rights; and to enable any fpiritual or other coporation to purchafe and hold any lands or tenements in perpetuity: which prerogative is declared and confirmed by the ftatute 18 Edw. III. ft. 3. c. 3. But as doubts were conceived at the time of the Revolution how far fuch licence was valid, fince the king had no power to difpenfe with the ftatutes of mortmain by a claufe of *non obftante*, which was the ufual courfe, though it feems to have been unneceffary; and as, by the gradual declenfion of mefne figniories through the long operation of the ftatute of *quia emptores*, the rights of intermediate lords were reduced to a very fmall compafs; it was therefore provided by the ftatute 7 & 8 W. III. c. 37. that the crown for the future at its own difcretion may grant licences to aliene or take in mortmain, of whomfoever the tenements may be holden.

After the diffolution of monafteries under H. VIII. though the policy of the next popifh fucceffor affected to grant a fecurity to the poffeffors of abbey-lands, yet, in order to regain fo much of them as either the zeal or timidity of their owners might induce them to part with, the ftatutes of mortmain were fufpended for 20 years by the ftatute 1 & 2 P. & M. c. 8. and during that time any lands or tenements were allowed to be granted to any fpiritual corporation without any licence whatfoever. And long afterwards, for a much better purpofe, the augmentation of poor livings, it was enacted by the ftatute 17 Car. II. c. 3. that appropriators may annex the great tithes to the vicarages; and that all benefices under 100 l. *per annum*, may be augmented by the purchafe of lands, without licence of mortmain in either cafe: and the like provifion hath been fince made, in favour of the governors of queen Anne's bounty. It hath alfo been held, that the ftatute 23 Hen. VIII. before-mentioned did not extend to any thing but fuperftitious ufes; and that therefore a man may give lands for the maintenance of a fchool, an hofpital, or any other charitable ufes. But as it was apprehended from recent experience, that perfons on their deathbeds might make large and improvident difpofitions even for thefe good purpofes, and defeat the political ends of the ftatutes of mortmain; it is therefore enacted by the ftatute 9 Geo. II. c. 36. that no lands or tenements, or money to be laid out thereon, fhall be given for or charged with any charitable ufes whatfoever, unlefs by deed indented, executed in the prefence of two witneffes 12 kalendar months before the death of the donor, and enrolled in the court of chancery within fix months after its execution, (except ftocks in the public funds, which may be transferred within fix months previous to the donor's death), and unlefs fuch gift be made to take effect immediately, and be without power of revocation: and that all other gifts fhall be void. The two univerfities, their colleges, and the fcholars upon the foundation of the colleges of Eton, Winchefter, and Weftminfter, are excepted out of this act: but fuch exemption was granted with this provifo, that no college fhall be at liberty to purchafe more advowfons than are equal in number to one moiety of the fellows or ftudents upon the refpective foundations.

Morton. Mortuary.

MORTON (Thomas), a learned Englifh bifhop in the 17th century, was bred at St John's college Cambridge, and was logic-lecturer of the univerfity. After feveral preferments he was advanced to the fee of Chefter in 1615, and tranflated to that of Litchfield and Coventry in 1618: at which time he became acquainted with Antonio de Dominis archbifhop of Spalatro, whom he endeavoured to diffuade from returning to Rome. While he was bifhop of Litchfield and Coventry, in which fee he fat 14 years, he educated, ordained, and prefented to a living, a youth of excellent parts and memory, who was born blind; and detected the impofture of the famous boy of Bilfon in Staffordfhire, who pretended to be poffeffed with a devil. In 1632 he was tranflated to the fee of Durham, in which he fat with great reputation till the opening of the long parliament, which met in 1640; when he received great infults from the common people, and was committed twice to cuftody. The parliament, upon the diffolution of bifhoprics, voted him 800l. *per annum*, of which he received but a fmall part. He died in 1659, in the 95th year of his age and 44th of his epifcopal confecration. He publifhed *Apologia Catholica*, and feveral other works; and was a man of extenfive learning, great piety, and temperance.

MORTUARY, in law, is a fort of ecclefiaftical heriot *, being a cuftomary gift claimed by and due to the minifter in very many parifhes on the death of his parifhioners. They feem originally to have been only a voluntary bequeft to the church; being intended, as Lyndewode informs us from a conftitution of archbifhop Langham, as a kind of expiation and amends to the clergy for the perfonal tithes, and other ecclefiaftical duties, which the laity in their life-time might have neglected or forgotten to pay. For this purpofe, after the lord's heriot or beft good was taken out, the fecond beft chattel was referved to the church as a mortuary. And therefore in the laws of king Canute this mortuary is called *foul-fcot*, or *fymbolum animæ*. And, in purfuance of the fame principle, by the laws of Venice, where no perfonal tithes have been paid du-

* See *Heriot* in Append.

ring the life of the party, they are paid at his death out of his merchandife, jewels, and other moveables. So alfo, by a fimilar policy, in France, every man that died without bequeathing a part of his eftate to the church, which was called *dying without confeffion*, was formerly deprived of Chriftian burial: or, if he died inteftate, the relations of the deceafed, jointly with the bifhop, named proper arbitrators to determine what he ought to have given to the church, in cafe he had made a will. But the parliament, in 1409, redreffed this grievance.

It was anciently ufual in England to bring the mortuary to church along with the corpfe when it came to be buried; and thence it is fometimes called a *corfe-prefent:* a term which befpeaks it to have been once a voluntary donation. However, in Bracton's time, fo early as Henry III. we find it rivetted into an eftablifhed cuftom: infomuch that the bequefts of heriots and mortuaries were held to be neceffary ingredients in every teftament of chattels. *Imprimis autem debet quilibet, qui teftamentum fecerit, dominum fuum de meliori re quam habuerit recognofcere; et poftea ecclefiam de alia meliori:* the lord muft have the beft good left him as an heriot; and the church the fecond beft as a mortuary. But yet this cuftom was different in different places: *in quibufdam locis habet ecclefia melius animal de confuetudine; in quibufdam fecundum, vel tertium melius; et in quibufdam nihil: et ideo confideranda eft confuetudo loci.* This cuftom ftill varies in different places, not only as to the mortuary to be paid, but the perfon to whom it is payable. In Wales a mortuary or corfe-prefent was due upon the death of every clergyman to the bifhop of the diocefe; till abolifhed, upon a recompence given to the bifhop, by the ftatute 12 Ann. ft. 2. c. 6. And in the archdeaconry of Chefter a cuftom alfo prevailed, that the bifhop, who is alfo archdeacon, fhould have, at the death of every clergyman dying therein, his beft horfe or mare, bridle, faddle, and fpurs, his beft gown or cloak, hat, upper garment under his gown, and tippet, and alfo his beft fignet or ring. But by ftatute 28 Geo. II. c. 6. this mortuary is directed to ceafe, and the act has fettled upon the bifhop an equivalent in its room. The king's claim to many goods, on the death of all prelates in England, feems to be of the fame nature; though Sir Edward Coke apprehends, that this is a duty upon death, and not a mortuary: a diftinction which feems to be without a difference. For not only the king's ecclefiaftical character, as fupreme ordinary, but alfo the fpecies of the goods claimed, which bear fo near a refemblance to thofe in the archdeaconry of Chefter, which was an acknowledged mortuary, puts the matter out of difpute. The king, according to the record vouched by Sir Edward Coke, is entitled to fix things; the bifhop's beft horfe or palfrey, with his furniture; his cloak or gown, and tippet; his cup and cover; his bafon and ewer; his gold ring; and laftly, his *muta canum*, his mew or kennel of hounds.

This variety of cuftoms with regard to mortuaries, giving frequently a handle to exactions on the one fide, and frauds or expenfive litigations on the other, it was thought proper by ftatute 21 Henry VIII. c. 6. to reduce them to fome kind of certainty. For this purpofe it is enacted, that all mortuaries, or corfe-prefents to parfons of any parifh, fhall be taken in the following manner, unlefs where by cuftom lefs or none at all is due: *viz.* for every perfon who does not leave goods to the value of ten marks, nothing: for every perfon who leaves goods to the value of ten marks and under 30 pounds, 3*s.* 4*d.* if above 30 pounds, and under 40 pounds, 6*s.* 8*d.* if above 40 pounds, of what value foever they may be, 10*s.* and no more. And no mortuary fhall throughout the kingdom be paid for the death of any feme covert; nor for any child; nor for any one of full age, that is not a houfekeeper; nor for any wayfaring man; but fuch wayfaring man's mortuary fhall be paid in the parifh to which he belongs. And upon this ftatute ftands the law of mortuaries to this day.

MORUS, the MULBERRY-TREE; a genus of the tetrandria order, belonging to the monœcia clafs of plants. The moft remarkable fpecies are,

1. The *nigra*, or common black-fruited mulberry-tree. It rifes with an upright, large, rough trunk, dividing into a large, branchy, and very fpreading head, rifing 20 feet high, or more; large, heart-fhaped, rough leaves, and monœcious flowers; fucceeded in the females by large fucculent black-berries. There is a variety with jagged leaves and fmaller fruit. This fpecies is the proper mulberry-tree for general cultivation in this country for its fruit; the tree being a plentiful bearer, and the fruit ripen in good perfection in Auguft and September.

2. The *alba*, or white mulberry-tree, rifes with an upright trunk, branching 20 or 30 feet high; garnifhed with large, oblique, heart-fhaped, fmooth, light-green, fhining leaves, and monœcious flowers, fucceeded by pale-whitifh fruit. There is a variety with purplifh fruit.

3. The *papyrifera*, or paper mulberry-tree of Japan, grows 20 or 30 feet high, with large palmated leaves, fome trilobate, others quinquelobed, and monœcious flowers, fucceeded by fmall black fruit. In the countries where this tree grows naturally, the inhabitants make paper of the bark.

4. The *rubra*, or red Virginia mulberry-tree, grows 30 feet high, with very large, heart-fhaped, rough leaves, hairy underneath, and monœcious flowers, fucceeded by large reddifh berries.

All thefe trees are very hardy, and fucceed in any common foil and fituation. The black mulberry is the only fort proper to cultivate as a fruit-tree for its fruit; the others are principally employed here to form variety in our ornamental plantations, of which the white and paper mulberry are the moft common, the red fort being very fcarce in the Englifh gardens; the black and the white-fruited kinds are alfo eminent for their leaves to feed filk-worms, they being the principal food of thefe valuable infects; but the white mulberry-leaves are in the moft efteem for this purpofe; and abroad, in France, Italy, &c. vaft plantations of the trees are made folely for their leaves to feed filk-worms, which amply reward the poffeffors with the annual fupply of filk they fpin from their bowels: plantations of the fame trees has formerly been recommended in this country for the purpofe of filk-worms, to introduce the manufacturing of raw filk, fince it is obfervable that where the trees thrive, the filk-worms will alfo profper; all recommendations, however, have proved fruitlefs, although it

it in time might probably turn to a national advantage.

The leaves of these trees are generally late before they begin to come out, the buds seldom beginning to open till the middle or towards the latter end of May, according to the temperature of the season; and when these trees in particular begin to expand their foliage, it is a good sign of the near approach of fine warm settled weather; the white mulberry, however, is generally forwarder in leafing than the black.

The flowers and fruit come out soon after the leaves; the males in *amentums*, and the females in small roundish heads; neither of which are very conspicuous, nor possess any beauty, but for observation; the female or fruitful flowers always rise on the extremity of the young shoots, on short spurs; and with this singularity, the calixes of the flowers become the fruit; which is of the berry kind, and being composed of many tuberances, each of these furnish one seed. The fruit ripens here gradually from about the middle of August until the middle of September; which in dry warm seasons ripen in great perfection; but when it proves very wet weather they ripen but indifferently, and prove devoid of flavour.

Considered as fruit-trees, the black-fruited kind is the only proper sort to cultivate, the trees being not only the most plentiful bearers in this country, but the fruit are larger and much finer-flavoured than the white kind, which is the only sort, besides the black mulberry, that bears fruit in this country.

MOSAIC, or Mosaic-work, an assemblage of little pieces of glass, marble, precious stones, &c. of various colours, cut square, and cemented on a ground of stucco, in such a manner as to imitate the colours and gradations of painting. The critics are divided as to the origin and reason of the name. Some derive it from *mosaicum*, a corruption of *musaicum*, as that is of *musivum*, as it was called among the Romans. Scaliger derives it from the Greek μῦσα, and imagines the name was given to this sort of works as being very fine and ingenious. Nebricensis is of opinion it was so called, because *ex illis picturis ornabantur musea.*

1. Method of performing Mosaic-work of *glass* is this: They provide little pieces of glass, of as many different colours and sizes as possible.

Now, in order to apply these several pieces, and out of them to form a picture, they in the first place procure a cartoon or design to be drawn; this is transferred to the ground or plaster by calking, as in painting in fresco. See Fresco.

As this plaster is to be laid thick on the wall, and therefore will continue fresh and soft a considerable time, so there may be enough prepared at once to serve for as much work as will take up three or four days.

This plaster is composed of lime, made of hard stone, with brick-dust very fine, gum tragacanth, and whites of eggs: when this plaster has been thus prepared and laid on the wall, and made the design of what is to be represented, they take out the little pieces of glass with a pair of plyers, and range them one after another, still keeping strictly to the light, shadow, different teints, and colours, represented in the design before; pressing or flatting them down with a ruler, which serves both to sink them within the ground, and to render the surface even.

Thus in a long time, and with a great deal of labour, they finish the work, which is still the more beautiful, as the pieces of glass are more uniform, and ranged at an even height.

Some of these pieces of mosaic-work are performed with that exactness, that they appear as smooth as a table of marble, and as finished and masterly as a painting in fresco; with this advantage, that they have a fine lustre, and will last ages.

The finest works of this kind that have remained till our time, and those by whom the moderns have retrieved the art, which was in a manner lost, are those in the church of St Agnes, formerly the temple of Bacchus, at Rome; and some at Pisa, Florence, and other cities of Italy. The most esteemed among the works of the moderns are those of Joseph Pine and the Chevalier Lanfranc, in the church of St Peter at Rome: there are also very good ones at Venice.

2. Method of performing Mosaic-work of *marble* and *precious stones* is this: The ground of Mosaic-works, wholly marble, is usually a massive marble, either white or black. On this ground the design is cut with a chisel, after it has been first calked. After it has been cut of a considerable depth, *i. e.* an inch or more, the cavities are filled up with marble of a proper colour, first fashioned according to the design, and reduced to the thickness of the indentures with various instruments. To make the piece thus inserted into the indentures cleave fast, whose several colours are to imitate those of the design, they use a stucco, composed of lime and marble-dust; or a kind of mastic, which is prepared by each workman, after a different manner peculiar to himself.

The figures being marked out, the painter or sculptor himself draws with a pencil the colours of the figures not determined by the ground, and in the same manner makes strokes or hatchings in the place where shadows are to be: and after he has engraven with the chisel all the strokes thus drawn, he fills them up with a black mastic, composed partly of Burgundy-pitch poured on hot; taking off afterwards what is superfluous with a piece of soft stone or brick, which, together with water and beaten cement, takes away the mastic, polishes the marble, and renders the whole so even that one would imagine it only consisted of one piece.

This is the kind of Mosaic-work that is seen in the pompous church of the invalids at Paris, and the fine chapel at Versailles, with which some entire apartments of that palace are incrustated.

As for Mosaic-work of precious stones, other and finer instruments are required than those used in marble; as drills, wheels, &c. used by lapidaries and engravers on stone. As none but the richest marbles and stones enter this work, to make them go the farther, they are sawn into the thinnest leaves imaginable, scarce exceeding half a line in thickness; the block to be sawn is fastened firmly with cords on the bench, and only raised a little on a piece of wood, one or two inches high. Two iron pins, which are on one side the block, and which serve to fasten it, are put into a vice contrived

contrived for the purpofe; and with a kind of faw or bow, made of fine brafs-wire, bent on a piece of fpongy wood, together with emery fteeped in water, the leaf is gradually fafhioned by following the ftroke of the defign, made on paper, and glued on the piece. When there are pieces enough faftened to form an entire flower, or fome other part of the defign, they are applied to the ground.

The ground which fupports this Mofaic-work is ufually of free-ftone. The matter with which the ftones are joined together, is a maftic, or kind of ftucco, laid very thin on the leaves as they are fafhioned; and this being done, the leaves are applied with plyers.

If any contour, or fide of a leaf, be not either fquared or rounded fufficiently, fo as to fit the place exactly into which it is to be inferted, when it is too large, it is to be brought down with a brafs file or rafp; and if it be too little, it is managed with a drill and other inftruments ufed by lapidaries.

Mofaic-work of marble is ufed in large works, as in pavements of churches, bafilics, and palaces; and in the incruftation and vaneering of the walls of the fame edifices.

As for that of precious ftones, it is only ufed in fmall works, as ornaments for altar-pieces, tables for rich cabinets, precious ftones being fo very dear.

3. Manner of performing Mofaic-work of *gypfum*. Of this ftone calcined in a kiln, beaten in a mortar, and fifted, the French workmen make a fort of artificial marbles, imitating precious ftones; and of thefe they compofe a kind of Mofaic-work, which does not come far fhort either of the durablenefs or the vivacity of the natural ftones; and which befides has this advantage, that it admits of continued pieces or paintings of entire compartiments without any vifible joining.

Some make the ground of plafter of Paris, others of free ftone. If it be of plafter of Paris, they fpread it in a wooden frame, of the length and breadth of the work intended, and in thicknefs about an inch and a half. This frame is fo contrived, that the tenons being only joined to the mortifes by fingle pins, they may be taken afunder, and the frame be difmounted, when the plafter is dry. The frame is covered on one fide with a ftrong linen-cloth, nailed all round, which being placed horizontally with the linen at the bottom, is filled with plafter paffed through a wide fieve. When the plafter is half dry, the frame is fet up perpendicularly, and left till it is quite dry; then it is taken out, by taking the frame to pieces.

In this mofaic, the ground is the moft important part. Now in order to the preparation of this fifted gypfum, which is to be applied on this ground, it is diffolved and boiled in the beft Englifh glue, and mixed with the colour that it is to be of; then the whole is worked up together into the ufual confiftence of plafter, and then is taken and fpread on the ground five or fix inches thick. If the work be fuch, as that mouldings are required, they are formed with gouges and other inftruments.

It is on this plafter, thus coloured like marble or precious ftone, and which is to ferve as a ground to a work, either of lapis, agate, alabafter, or the like, that the defign to be reprefented is drawn; having been firft pounced or calqued. To hollow or imprefs the defign, they ufe the fame inftruments that fculptors do; the ground whereon they are to work not being much lefs hard than the marble itfelf. The cavities being thus made in the ground, are filled with the fame gypfum boiled in glue, only differently coloured, and thus are the different colours of the original reprefented. In order that the neceffary colours and teints may be ready at hand, the quantities of the gypfum are tempered with the feveral colours in pots.

After the defign has been thus filled and rendered vifible, by half-polifhing it with brick and foft ftone, they go over it again, cutting fuch plates as are either to be weaker or more fhadowed, and filling them with gypfum; which work they repeat, till all the colours being added one after the other, reprefent the original to the life.

When the work is finifhed, they fcour it with foft ftone, fand, and water; after that, with a pumice-ftone; and in the laft place polifh it with a wooden mullet and emery. Then, laftly, they gave it a luftre, by fmearing it over with oil, and rubbing it a long time with the palm of the hand, which gives it a luftre no ways inferior to that of natural marble.

MOSAMBIQUE, a kingdom of Africa, lying fouth of Quiloa, and taking its name from the chief town, which is fituated on an ifland, at the mouth of a river of the fame name, in 15° S. Lat. The ifland is thirty miles in circumference, and very populous, though the air is faid to be very hot, and the foil in general dry, fandy, and barren; yet they have moft of the tropical fruits, with black cattle, hogs, and fheep. There is a kind of fowl here, both the feathers and flefh of which are black, infomuch that, when they are boiled, the broth looks like ink; and yet their flefh is very delicate, and good food. The town of Mofambique is regularly fortified, and has a good harbour, defended by a citadel, with feveral churches and monafteries. The Portuguefe fhipping to and from India touch here for refrefhments. As the ifland abounds in cattle, the Portuguefe flaughter and falt up a great deal of beef, which they afterwards fend to the Brafils, or fell to the European fhipping. They alfo barter European goods with the natives for gold, elephants teeth, and flaves. There is another town, called *Mongale*, fituated alfo on an ifland, and garrifoned by the Portuguefe, being their chief magazine for European goods. The gold they receive from the natives is found near the furface of the earth, or in the fands of rivers; no gold-mines, or at leaft very few, being at prefent wrought in Africa.

MOSCHUS, a Grecian poet of antiquity, ufually coupled with Bion; and they were both of them cotemporaries with Theocritus. In the time of the latter Grecians, all the ancient Idylliums were collected and attributed to Theocritus; but the claims of Mofchus and Bion have been admitted to fome few little pieces; and this is fufficient to make us inquifitive about their characters and ftory; yet all that can be known about them muft be collected from their own remains. Mofchus, by compofing his delicate elegy on Bion, has given the beft memorials of Bion's life. See Bion. Mofchus and Theocritus have by fome critics been fuppofed the fame perfon; but there are irrefragable evidences againft it: others will have him

Moschus. as well as Bion to have lived later than Theocritus, upon the authority of Suidas; while others again suppose him to have been the scholar of Bion, and probably his successor in governing the poetic school; which, from the elegy of Moschus, does not seem unlikely. Their remains are to be found in all the editions of the Poetæ minores.

Moschus, in zoology, a genus of quadrupeds of the order of pecora, having no horns; the canine teeth of the upper jaw are solitary and exserted. There are three species.

Plate CLXXXII. fig. 2. 1. The moschiferus, or musk animal, hath been considered by some authors as a stag, a roebuck, a goat; and by others as a large cherrotain, a species of antelope; but M. Buffon hath determined it to be an ambiguous animal, participating of the nature of all these, but differing effectually from every one of them, and from all other animals. It is of the size of a small roebuck, but has no horns; it has long coarse hair, a sharp muzzle, and tusks like those of the hog. From the nose to the tail, the animal is about a yard and half a foot long; the head above half a foot; the neck is a quarter of a yard, the fore-head three inches broad; the nose end scarce three-fourths of an inch, being very sharp, like that of a gre-hound. The ears are like those of a rabbit, about three inches long, and erect; as is also the tail, which exceeds not two inches; the fore-legs are a foot and two inches long, taking in the foot and thigh. The foot is deeply cloven; with two fore-hoofs, an inch and a quarter long, each a quarter of an inch over; and two heels almost as big, and therefore conspicuous. The hair on the head and legs is about half an inch long, and rateably small; on the belly it is an inch and an half in length, and somewhat thicker; on the back and buttocks it is three inches long, thicker in proportion than in any other animal, excepting perhaps some of the deer-kind, viz. three or four times as thick as hog's bristles; consisting of brown and white portions alternately from the root to the top. On the head and legs it is brown; on the belly, and under the tail, whitish, and as it were frizzled, especially on the back and belly, by a kind of undulation. The hair of the musk is softer than in most animals, and exceeding light and rare; for, being split, they appear to be made up of little bladders, like those in the plume or stalk of a quill; so that it is something betwixt a common hair and a quill. On each side of his lower chop, almost under the corner of his mouth, there is a peculiar tuft, (about three-fourths of an inch long), of short, thick, and hard hairs, or rather bristles, of equal length, as in a scrubbing-brush. The musk-bladder or bag which holds the perfume, is on the belly near the navel. It is about three inches long, and two over; standing out from the belly one and a half, and before the groin as much. The creature hath 26 teeth, 16 in the lower chop; of which there are eight little cutters before; behind four grinders on each side, rugged and continuous, with as many grinders in the upper jaw. About an inch and an half from the nose end in the same jaw, is on each side a tusk two inches and an half long, hooked downward and backward, and ending in a point. This tusk is not round, but flat; the breadth of half an inch; thin, and having a sharp edge behind; so that it hath a considerable resemblance of a scythe.—From the testimony of a number of travellers it appears that the perfume is produced only in the body of the male. The female hath indeed a pouch of the same kind near the navel, but the humour secreted in it has not the same odour; and this tumour of the male is not filled with musk except in the rutting season; at other times the quantity of this humour is smaller, and its odour weaker. See Musk.

Moschus, Moscow.

2. The grimmia, grimm, or Guinea antelope, is a most beautiful animal, with strait black horns, slender and sharp-pointed, not three inches long, and slightly annulated at the base. Its height is about 18 inches; the ears are large, and the eyes dusky; below the eyes is a large cavity, into which exudes a strong-scented oily liquid; between the horns is a tuft of black hairs. The colour of the neck and body is brown, mixed with an ash-colour, and a tinge of yellow; the belly is white; the tail short, white beneath, and black above. M. Vosmaer tells us, that these animals are extremely timid, and easily frightened with any noise, particularly thunder; when surprised, they express their fear by blowing suddenly and with great force through their noses. He describes one which was kept in the menagerie of the prince of Orange. "This one (says he) was at first wild, but afterwards became pretty tame. It listens when called by its name *Tetje;* and when gently approached with a piece of bread in the hand, it allows its head and neck to be stroaked. It is so cleanly, that it suffers not the smallest particle of dirt to remain on any part of its body; and for this purpose it often scratches itself with one of its hind-feet. This is the reason why it has received the appellation of *tetje*, from *tettig*, which signifies neat or clean. However, if a person continues for some time to rub its body, a white powder adheres to his fingers like that which proceeds from horses when they are curried. This animal is extremely agile; and, when reposing, it frequently keeps one of its fore-feet in an elevated and bended position, which gives it a very agreeable appearance. It is fed with bread, rye, and carrots: it likewise spontaneously eats potatoes: it is a ruminating animal, and discharges its excrements in small balls, the size of which is considerable in proportion to the magnitude of the creature."—Dr Herman Grimm tells us, that the fat, viscid, yellow humour, which is secreted in the cavities above the eyes of this animal, has an odour that participates of musk and castoreum; but M. Vosmaer remarks, that in his live subject this viscid matter has no odour of any kind.

3. The pygmæus has feet narrower than a man's finger, and is found in Africa and Asia.

MOSCOW, the chief province of the empire of Russia, deriving its name from the river Muscova, or Moska, on which the capital is situated. It was from this duchy that the czars of old took the title of *dukes of Muscovy*. The province is bounded on the north by the duchies of Twere, Rostow, Susdal, and Wolodimer; on the south by Rezan, from which it is separated by the river Occa; on the east by the principality of Cachine, and the same river Occa parting it from Nisi-novogorod; and on the west by the duchies of Rzeva, Biela, and Smolensko. It extends about 200 miles in length, and about 100 in breadth; and

Mofcow. is watered by the Mofka, Occa, and Clefma, which fall into the Wolga: neverthelefs, the foil is not very fertile. The air, however, though fharp, is falubrious; and this confideration, with the advantage of its being fituated in the midft of the beft provinces in the empire, induced the czars to make it their chief refidence. In the weftern part of Mofcow is a large foreft, from whence flows the celebrated river Nieper, or Boryfthenes, which, traverfing the duchy of Smolenfko, winds in a ferpentine courfe to Ukrania, Lithuania, and Poland. The capital, Mofcow, or Mofkova, is the metropolis and largeft city of the Ruffian empire, fituated in a fpacious plain on the banks of the river Mufkova; over which the prince Gafifchin built a ftately bridge, confifting of 12 arches of prodigious height, breadth, and folidity, becaufe the river is fo apt to overflow its banks: it was defigned by a Polifh monk, and is the only ftone-bridge in all Ruffia. Mofcow is feated on a wholefome gravelly foil, and divided into four quarters, each furrounded with a diftinct wall. Thefe diftricts are known by the names of *Cataigorod*, *Czarogorod*, *Skorodum*, and *Strelitze-flaboda*. The Cataigorod, furrounded with a brick-wall, is the middle of the city; in which ftands the citadel, about two miles in circuit, fortified with a triple wall, flanked with towers and a foffe. It contains two imperial palaces, the one of timber and the other of ftone, built after the Italian architecture; the patriarchal palace, which is a large ancient edifice; the exchequer, chancery, and other offices; two noble monafteries; five large churches, including that of St Michael, famous for its fabric and ornaments, as well as for the monuments of the grand dukes and czars who have been here interred; the grand magazine, and many other ftately buildings. Without the citadel-gate ftands that noble edifice the church of Jerufalem, finifhed by the czar John Bafilides, who ordered the architect to be deprived of his eye-fight, that he might never contrive, or at leaft behold, its equal. In the great market that fronts the citadel we fee the ftupendous bell, fuppofed to be the largeft in the whole world. It was hung in a tower built for the purpofe, which tower was confumed by fire in the beginning of the prefent century. The weight of the bell amounts to 336,000 pounds. It is in height 19 feet, in diameter 23, in circumference 70, and the fides are two feet in thicknefs. One hundred men were employed in moving this monftrous machine, which was only rung on extraordinary occafions: for example, when the Czar condefcended to fhew himfelf to his people, and when he converfed with his wife, that the fubjects mights know when to petition heaven that a male child fhould be the iffue of the conjugal embrace. This diftrict is watered by the rivers Negliga and Mofka; and is called *Cataigorod*, from *catai*, the Ruffian name for China, becaufe here the merchandifes of that empire are chiefly fold. The Czarogorod, or ducal city, encompaffed the Cataigorod, and is itfelf fortified with a white-ftone wall, called *Bielaftena;* whence it has acquired the appellation of *Bielagorod*, or the *white city*. The moft remarkable building in this divifion is the great arfenal. The Skorodum quarter ftands to the north-weft of the Czarogorod; and is chiefly inhabited by timber-merchants and carpenters, who fell wooden houfes ready made. It is furrounded with a mud-wall, and diftinguifhed by the name of *Scorodum*, which fignifies *done in hafte;* becaufe, on an alarm from the Tartars, it was finifhed in four days, tho' it is 15 miles in circuit, and the earth is every where fupported by planks and beams of timber. It is abfolutely neceffary that there fhould be fuch a magazine of houfes ready made, to fupply the lofs of thofe that perifh almoft every day by conflagrations, owing to the careleffnefs, rage, and intoxication, of the inhabitants. On the eaft and fouth-eaft fides of the Cataigorod and citadel ftands the Strelitze-flabodo, fo called from the guards of that name, who were formerly lodged in this quarter, which is fortified with wooden ramparts, and divided from the other parts of the city by the river Mofka. The houfes of the commonalty are no better than mean paultry wooden huts, without neatnefs and furniture: but the merchants fecure their commodities in vaults of ftone or brick, which are proof againft the accidents of fire. There are 3000 ftone or brick houfes in the city of Mofcow; but they ftand at fuch diftances from one another, are fo intermingled with rows of wooden houfes, and fuch a number of them ftand detached from, and as it were behind the ftreets, furrounded with high walls, that the effect of them is almoft loft in the general profpect. The ftreets, inftead of being paved with ftones, are boarded with fir-planks; fo that in conflagrations the ground feems to burn, and it becomes impoffible to approach the fcene of difafter. Among the churches and chapels of this city, which are faid to amount in number to 1500, that in the Krimelin, or palace of the citadel, is a very ancient and remarkable edifice. On the right-hand fide of the altar is the Czar's throne, and on the left is that of the patriarch. The body of the church is lighted by a filver chandelier of immenfe weight and value. The jewels and ornaments belonging to an image of the Virgin Mary are valued at half a tun weight in gold: but ineftimable is the value of an infinite number of chalices, pixes, patens, ftatues, and other church-utenfils of gold and filver, curioufly wrought and enriched with precious ftones, a prodigious number of rich prieftly veftments, befides innumerable donatives, and prefents offered to the relics of three eminent Ruffian faints interred in this place. In a word, the treafure contained in this church is faid to equal, at leaft, that of any cathedral in Europe. Hard by the church of St Michael, which we have mentioned above, is the ftately abbey of nuns, called *tzudoff-monafter:* here the bodies of the princeffes of the blood are interred; and in a feparate chapel we fee the tombs of thofe princes who never afcended the throne. Nothing can be more rich and magnificent than the palls with which their coffins are covered on holidays. Of the feveral monafteries that appear in Mofcow and its neighbourhood, the moft remarkable is the Dewitze-monafter, about a mile from the city, where Peter confined his ambitious fifter the princefs Sophia, who had hatched fo many confpiracies againft his government. This monaftery, which is fituated in an extenfive plain, contains 300 nuns, who are kept under fevere reftrictions, contrary to the freedom with which other Mufcovite nuns are indulged. The only liberty thefe enjoy is in holiday-time, when they are permitted to walk on the terraces of the garden, which over-

look

look the adjacent plain.

Peter the Great founded at Moſcow three colleges, and ſelected for them able profeſſors. In the firſt they taught humanity, rhetoric, and philoſophy; in the ſecond, mathematics; and in the third, navigation and aſtronomy. To theſe colleges he added a diſpenſatory, which is one of the nobleſt ſtructures in Moſcow, completely furniſhed with all ſorts of drugs and medicines, under the care of ſome Germans well ſkilled in the art of pharmacy and chemiſtry. The yearly revenue of this diſpenſatory amounts to 2000 rubles, allotted for freſh ſupplies of the *materia medica;* and from hence not only the army, but likewiſe all the chief cities of the empire, are furniſhed.

The courts of judicature, cuſtom-houſe, goals, and other public edifices, are built of ſtone, large, ſtrong, and maſſy. The city of Moſcow was founded in the year 1334, and in proceſs of time gradually enlarged itſelf to ſuch a degree, that it is ſaid to have contained 80,000 houſes: but in the ſequel it ſuffered greatly, both from the enemy and ſucceſſive conflagrations. Nevertheleſs, in the reign of Charles II. of England, while lord Carliſle was ambaſſador at that court, the city was 12 miles in compaſs, and the number of houſes computed at 40,000. Notwithſtanding the ſeverity and vigilance of the magiſtracy in Moſcow, the city ſwarms with ſturdy-beggars and vagabonds, who render it very unſafe to walk through the ſtreets in the dark. Some of theſe, being armed with ſhort truncheons, lurk in obſcure corners, from whence they throw their weapons at the heads of paſſengers with ſuch dexterity that they ſeldom fail to knock them down: then they rob and murder them, and make off with the booty. The body of the perſon thus murdered is expoſed in public for a certain time; and, if not owned, the magiſtrates order it to be thrown into a large deep pit, dug on purpoſe for the interment of all thoſe who loſe their lives in this manner: thither ſome prieſts repair on Whitſuntide-holidays, to ſay maſs for the ſouls of the deceaſed. The ancient ſplendour and opulence of Moſcow was greatly diminiſhed by the building of Peterſburg, and the removal of the court to that city. Nevertheleſs the place is ſtill populous; and there is plenty of all kinds of proviſion, extremely good, and ſurpriſingly cheap; except the article of fiſh, for which there is a very great demand, occaſioned by the four great lents and weekly faſts obſerved by the Ruſſians. The canal between Moſcow and Peterſburg is one of the moſt ſtupendous works of the czar Peter: it begins at the Nieva, and is continued from lake to lake, and river to river, for near 100 leagues, until it reaches Moſcow. What is properly deemed the artificial canal, commences at the city of Novogorod, and is carried on with incredible labour and expence through the territories of Brognitz, Chriſtitz, Chilolova, Witſchora, Voloſcha, Torſchock, the province of Twere, and the diſtrict of Kiln. The city of Moſcow ſtands about 650 miles from Caffa, the capital of Crim-Tartary; 950 miles from Conſtantinople; 720 from Cracow in Poland; 660 from Stockholm; and 1320 from London; in 55 degrees 42 minutes of north latitude.

MOSELLE, a river of Germany, which riſes in the mountains of Vauge in Lorrain, and, running thro' that duchy and the electorate of Triers, falls into the Rhine at Coblentz.

MOSES, the great prophet and lawgiver of the Jews, ſon of Amram, was born *anno mundi* 2433, and died without ſickneſs, *anno mundi* 2553, aged 120.— He wrote the Pentateuch, and the book of Job is attributed to him.

MOSKITO COUNTRY, is ſituated in North America, between 85 and 88 degrees of weſt longitude, and between 13 and 15 degrees of north latitude; having the north ſea on the north and eaſt; Nicaragua on the ſouth; and Honduras on the weſt; and indeed the Spaniards eſteem it a part of the principality of Honduras, though they have no colonies in the Moſkito country. When the Spaniards firſt invaded this part of Mexico, they maſſacred the greateſt part of the natives, which gave thoſe that eſcaped into the inacceſſible part of the country an unſuperable averſion to them; and they have always appeared ready to join any Europeans that come upon their coaſts againſt the Spaniards, and particularly the Engliſh, who frequently come hither; and the Moſkito-men being excellent markſmen, the Engliſh employ them in ſtriking the maratee fiſh, &c. and many of the Moſkito Indians come to Jamaica, and ſail with the Engliſh in their voyages.

Theſe people are ſo ſituated between moraſſes and inacceſſible mountains, and a coaſt full of rocks and ſhoals, that no attempts againſt them by the Spaniards, whom they mortally hate, could ever ſucceed. Nevertheleſs, they are a mild inoffenſive people, of great morality and virtue, and will never truſt a man who has once deceived them. They have ſo great a veneration towards the Engliſh, that they have ſpontaneouſly put themſelves and their lands under the protection and dominion of the crown of England. This was firſt done when the duke of Albemarle was governor of Jamaica, and the king of the Moſkitos received a commiſſion from his grace, under the ſeal of that iſland; ſince which time, they have not only been ſteady in their alliance with the Engliſh, but warm in their affections, and very uſeful to them on many occaſions.

When their king dies, the next male heir goes to Jamaica, to certify that he is next in blood, and receives a commiſſion in form from the governor of Jamaica to be king of the Moſkitos, till which he is not acknowledged as ſuch by his countrymen. So fond are theſe people of every thing that is Engliſh, that the common people are proud of every Chriſtian or ſurname given them by our ſeamen, who honour their chief men with the titles of ſome of our nobility.

MOSQUE, a temple or place of religious worſhip among the Mahometans.

All moſques are ſquare buildings, generally conſtructed of ſtone. Before the chief gate there is a ſquare court paved with white marble; and low galleries round it, whoſe roof is ſupported by marble pillars. In theſe galleries the Turks waſh themſelves before they go into the moſque. In each moſque there is a great number of lamps; and between theſe hang many cryſtal rings, oſtriches eggs, and other curioſities, which, when the lamps are lighted, make a fine ſhew. As it is not lawful to enter the moſque with ſtockings or ſhoes on, the pavements are covered with pieces of ſtuff ſewed together, each being wide enough

to

to hold a row of men kneeling, fitting, or proftrate. The women are not allowed to enter the mofque, but ftay in the porches without. About every mofque there are fix high towers, called *minarets*, each of which has three little open galleries, one above another: thefe towers, as well as the mofques, are covered with lead, and adorned with gilding and other ornaments; and from thence, inftead of a bell, the people are called to prayers by certain officers appointed for that purpofe. Moft of the mofques have a kind of hofpital belonging to them, in which travellers, of what religion foever, are entertained three days. Each mofque has alfo a place called *tarbe*, which is the burying-place of its founders; within which is a tomb fix or feven feet long, covered with green velvet or fattin; at the ends of which are two tapers, and round it feveral feats for thofe who read the koran, and pray for the fouls of the deceafed.

MOSS (Robert), dean of Ely, was bred in Bennet-college Cambridge, of which he was chofen a fellow. He acquired the reputation of one of the moft ingenious performers of any about his time, of all kinds of public exercifes, whether in claffical or academical learning. His fermons at St Mary's were much crowded. He publifhed fermons, and fome poems: and he is fuppofed to be the author of a pamphlet intitled, *A defence of my lords the bifhops, as well as the clergy of the lower houfe of Convocation; in a letter from a member of that houfe to the prolocutor, concerning the late confultations about the bifhop of Bangor's writings*. He died in 1729, aged 63.

MOSSES, in botany. See MUSCI.

Colours extracted from MOSSES. See COLOUR-*Making*, n° 38.

Moss is alfo a name given by fome to the boggy ground in many parts of England, more ufually called a *fen* and *bog*.

In many of thefe grounds, as well in England and Ireland as in other parts of the world, there are found vaft numbers of trees ftanding with their ftumps erect, and their roots piercing the ground in a natural pofture, as when growing. Many of thofe trees are broken or cut off near the roots, and lie along, and this ufually in a north-eaft direction. People who have been willing to account for this, have ufually refolved it into the effect of the deluge in the days of Noah; but this is a very wild conjecture, and is proved falfe by many unanfwerable arguments. The waters of this deluge might indeed have wafhed together a great number of trees, and buried them under loads of earth; but then they would have lain irregularly and at random; whereas they all lie lengthwife from fouth-weft to north-eaft, and the roots all ftand in their natural perpendicular pofture, as clofe as the roots of trees in a foreft.

Befide, thefe trees are not all in their natural ftate, but many of them have the evident marks of human workmanfhip upon them, fome being cut down with an ax, fome fplit, and the wedges ftill remaining in them; fome burnt in different parts, and fome bored through with holes. Thefe things are alfo proved to be of a later date than the deluge, by other matters found among them, fuch as utenfils of ancient people, and coins of the Roman emperors.

It appears from the whole, that all the trees which we find in this foffile ftate, originally grew in the very places where we now find them, and have only been thrown down and buried there, not brought from elfewhere. It may appear indeed an objection to this opinion, that moft of thefe foffil trees are of the fir kind; and that Cæfar fays exprefsly, that no firs grew in Britain in his time: but this is eafily anfwered by obferving, that thefe trees, though of the fir kind, yet are not the fpecies ufually called the *fir*, but pitch-tree; and Cæfar has no where faid that pitch-trees did not grow in England. Norway and Sweden yet abound with thefe trees; and there are at this time whole forefts of them in many parts of Scotland, and a large number of them wild upon a hill at Wareton in Staffordfhire to this day.

In Hatfield marfh, where fuch vaft numbers of the foffil trees are now found, there has evidently once been a whole foreft of them growing. The laft of thefe was found alive, and growing in that place within 70 years laft paft, and cut down for fome common ufe.

It is alfo objected by fome to the fyftem of the firs growing where they are found foffile, that thefe countries are all bogs and moors, whereas thefe forts of trees grow only in mountainous places. But this is founded on an error; for though in Norway and Sweden, and fome other cold countries, the fir-kinds all grow upon barren and dry rocky mountains, yet in warmer places they are found to thrive as well on wet plains. Such are found plentifully in Pomerania, Livonia, and Courland, &c. and in the weft parts of New England there are vaft numbers of fine ftately trees of them in low grounds. The whole truth feems to be, that thefe trees love a fandy foil; and fuch is found at the bottoms of all the moffes where thefe trees are found foffile. The roots of the fir-kind are always found fixed in thefe; and thofe of oaks, where they are found foffile in this manner, are ufually found fixed in clay: fo that each kind of tree is always found rooted in the places where they ftand in their proper foil; and there is no doubt to be made, but that they originally grew there. When we have thus found that all the foffile trees we meet with once grew in the places where they are now buried, it is plain that in thefe places there were once noble forefts, which have been deftroyed at fome time; and the queftion only remains how and by whom they were deftroyed. This we have reafon to believe, by the Roman coins found among them, was done by the people of that empire, and that at the time when they were eftablifhed, or eftablifhing, themfelves here.

Their own hiftorians tells us, that when their armies purfued the wild Britons, thefe people always fheltered themfelves in the miry woods, and low watery forefts. Cæfar exprefsly fays this; and obferves, that Caffibelan and his Britons, after their defeat, paffed the Thames, and fled into fuch low moraffes and woods, that there was no purfuing them: and we find that the Silures fecured themfelves in the fame manner when attacked by Oftorius and Agricola. The fame thing is recorded of Venutius king of the Brigantes, who fled to fecure himfelf into the boggy forefts of the midland part of this kingdom: and Herodian exprefsly fays, that in the time of the Romans pufhing their conquefts in thefe iflands, it was the cuftom

 ftom of the Britons to fecure themfelves in the thick forefts which grew in their boggy and wet places, and when opportunity offered, to iffue out thence and fall upon the Romans. The confequence of all this was the deftroying all thefe forefts; the Romans finding themfelves fo plagued with parties of the natives iffuing out upon them at times from thefe forefts, that they gave orders for the cutting down and deftroying all the forefts in Britain which grew on boggy and wet grounds. Thefe orders were punctually executed; and to this it is owing that at this day we can hardly be brought to believe that fuch forefts ever grew with us as are now found buried.

The Roman hiftories all join in telling us, that when Suetonius Paulinus conquered Anglefea, he ordered all the woods to be cut down there, in the manner of the Roman generals in England: and Galen tells us, that the Romans, after their conqueft in Britain, kept their foldiers conftantly employed in cutting down forefts, draining of marfhes, and paving of bogs. Not only the Roman foldiers were employed in this manner, but all the native Britons made captives in the wars were obliged to affift in it: and Dion Caffius tells us, that the emperor Severus loft no lefs than 50,000 men in a few years time, in cutting down the woods and draining the bogs of this ifland. It is not to be wondered at, that fuch numbers executed the immenfe deftruction which we find in thefe buried forefts. One of the greateft fubterranean treafures of wood is that near Hatfield; and it is eafy to prove, that thefe people, to whom this havock is thus attributed, were upon the fpot where thefe trees now lie buried. The common road of the Romans out of the fouth into the north, was formerly from Lindum (Lincoln) to Segelochum (Little Burrow upon Trent), and from thence to Danum (Doncafter), where they kept a ftanding garrifon of Crifpinian horfe. A little off on the eaft, and north-eaft of their road, between the two laft-named towns, lay the borders of the greateft foreft, which fwarmed with wild Britons, who were continually making their fallies out, and their retreats into it again, intercepting their provifions, taking and deftroying their carriages, killing their allies and paffengers, and difturbing their garrifons. This at length fo exafperated the Romans, that they were determined to deftroy it; and to do this fafely and effectually, they marched againft it with a great army, and encamped on a great moor not far from Finningly: this is evident from their fortifications yet remaining.

There is a fmall town in the neighbourhood called *Ofterfield;* and as the termination *field* feems to have been given only in remembrance of battles fought near the towns whofe names ended with it, it is not improbable that a battle was fought here, between all the Britons who inhabited this foreft, and the Roman troops under Oftorius. The Romans flew many of the Britons, and drove the reft back into this foreft, which at that time overfpread all this low country. On this the conquerors taking advantage of a ftrong fouth-weft wind, fet fire to the pitch-trees, of which this foreft was principally compofed; and when the greater part of the trees were thus deftroyed, the Roman foldiers and captive Britons cut down the remainder, except a few large ones which they left ftanding as remembrances of the deftruction of the reft. Thefe fingle trees, however, could not ftand long againft the winds, and thefe falling into the rivers which ran through the country, interrupted their currents; and the water then overfpreading the level country made one great lake, and gave origin to the moffes or moory bogs, which were afterwards formed there, by the workings of the waters, the precipitation of earthy matter from them, and the putrefaction of rotten boughs and branches of trees, and the vaft increafe of water-mofs and other fuch plants which grow in prodigious abundance in all thefe forts of places. Thus were thefe burnt and felled trees buried under a new-formed fpungy and watery earth, and afterwards found on the draining and digging thro' this earth again.

Hence, it is not ftrange that Roman weapons and Roman coins are found among thefe buried trees; and hence it is that among the buried trees fome are found burnt, fome chopped and hewn; and hence it is that the bodies of the trees all lie by their proper roots, and with their tops lying north-eaft, that is, in that direction in which a fouth-weft wind would have blown them down: hence alfo it is, that fome of the trees are found with their roots lying flat, thefe being not cut or burned down, but blown up by the roots afterwards when left fingle; and it is not wonderful, that fuch trees as thefe fhould have continued to grow even after their fall, and fhoot up branches from their fides which might eafily grow into high trees. Phil. Tranf. n° 275.

By this fyftem it is alfo eafily explained why the moor foil in the country is in fome places two or three yards thicker than in others, or higher than it was formerly, fince the growing up of peat-earth or bog-ground is well known, and the foil added by overflowing of waters is not a little.

As the Romans were the deftroyers of this great and noble foreft, fo they were probably alfo of the feveral other ancient forefts; the ruins of which furnifhes us with the bog-wood of Staffordfhire, Lancafhire, Yorkfhire, and other counties. But as the Romans were not much in Wales, in the Ifle of Man, or in Ireland, it is not to be fuppofed that forefts cut down by thefe people gave origin to the foffile wood found there: but though they did not cut down thefe forefts, others did; and the origin of the bog-wood is the fame with them and with us. Holingfhead informs us, that Edward I. being not able to get at the Welch becaufe of their hiding themfelves in boggy woods, gave orders at length that they fhould all be deftroyed by fire and by the ax; and doubtlefs the roots and bodies of trees found in Pembrokefhire under ground, are the remains of the execution of this order. The foffile wood in the bogs of the ifland of Man is doubtlefs of the fame origin, though we have not any accounts extant of the time or occafion of the forefts there being deftroyed; but as to the foffile trees of the bogs of Ireland, we are exprefsly told, that Henry II. when he conquered that country, ordered all the woods to be cut down that grew in the low parts of it, to fecure his conquefts, by cutting away the places of refort of rebels.

Moving-Moss. We have an account in the Philofophical Tranfactions, of a moving mofs near Church-

town in Lancafhire, which greatly alarmed the neighbourhood as miraculous. The mofs was obferved to rife to a furprifing height, and foon after funk as much below the level, and moved flowly towards the fouth.

A very furprifing inftance of a moving mofs is that of Solway in Scotland, which happened in the year 1771, after fevere rains which had produced terrible inundations of the rivers in many places. For the better underftanding of this event, we fhall give the following defcription of the fpot of ground where it happened. Along the fide of the river Efk there is a vale, about a mile broad, lefs or more in different places. It is bounded on the fouth-eaft by the river Efk, and on the north-weft by a fteep bank 30 feet in height above the level of the vale. From the top of the bank the ground rifes in an eafy afcent for about a quarter of a mile, where it is terminated by the mofs; which extends about two miles north and fouth, and about a mile and an half eaft and weft, and is bounded on the north-weft by the river Sark. It is probable that the folid ground from the top of the bank above the vale was continued in the fame direction under the mofs, before its eruption, for a confiderable fpace; for the mofs at the place where the eruption happened, was inclined towards the floping ground. From the edge of the mofs there was a gully or hollow, called by the country people *the gap*, and faid to be 30 yards deep where it entered the vale; down which ran a fmall rill of water, which was often dry in fummer, having no fupply but what filtered from the mofs. The eruption happened at the head of this gap, on Saturday November 16th 1771, about ten or eleven at night, when all the neighbouring rivers and brooks were prodigioufly fwelled by the rains. A large body of the mofs was forced, partly by the great fall of rain, and partly by fome fprings below it, into a fmall beck or burn, which runs within a few yards of its border to the fouth-eaft. By the united preffure of the water behind it, and of this beck, which was then very high, it was carried down a narrow glen between two banks about 300 feet high, into a wide and fpacious plain, over part of which it fpread with great rapidity. The mofs continued for fome time to fend off confiderable quantities; which, being borne along by the torrent on the back of the firft great body, kept it for many hours in perpetual motion, and drove it ftill farther on. This night at leaft 400 acres of fine arable land were covered with mofs from 3 to 12 or 15 feet deep. Several houfes were deftroyed, a good deal of corn loft, &c. but all the inhabitants efcaped. When the waters fubfided, the mofs alfo ceafed to flow; but two pretty confiderable ftreams continued to run from the heart of it, and carried off fome pieces of moffy matter to the place where it burft. There they joined the beck already mentioned; which, with this addition, refumed its former channel; and, with a little affiftance from the people of the neighbourhood, made its way to the Efk, through the midft of that great body of mofs which obftructed its courfe. Thus, in a great meafure drained, the new mofs fell feveral feet, when the fair weather came in the end of November, and fettled in a firmer and more folid body on the lands it had over-run. By this inundation about 800 acres of arable ground were overflowed before the mofs ftopped, and the habitations of 27 families deftroyed. Tradition has preferved the memory of a fimilar inundation in Monteith in Scotland. A mofs there altered its fituation in one night, and covered a great extent of ground.

Moss-*Troopers*, a rebellious fort of people in the north of England, that lived by robbery and rapine, not unlike the tories in Ireland, the bucaneers in Jamaica, or banditti of Italy. The counties of Northumberland and Cumberland were charged with an yearly fum, and a command of men, to be appointed by juftices of the peace, to apprehend and fupprefs them.

MOSTRA, in the Italian mufic, a mark at the end of a line or fpace, to fhew that the firft note of the next line is in that place: and if this note be accompanied with a fharp or flat, it is proper to place thefe characters along with the moftra.

MOTACILLA, in ornithology, a genus of birds of the order of pafferes; diftinguifhed by a ftraight beak of a fubulated figure, and a lacerated tongue. There are 49 fpecies belonging to this genus; the moft remarkable are,

1. The alba, or white wagtail, frequents the fides of ponds and fmall ftreams, and feeds on infects and worms. The head, back, and upper and lower fide of the neck, as far as the breaft, are black; in fome the chin is white, and the throat marked with a black crefcent: the breaft and belly are white; the quill-feathers are dufky; the coverts black, tipt and edged with white. The tail is very long, and always in motion. Mr Willoughby obferves, that this fpecies fhifts its quarters in the winter; moving from the north to the fouth of England during that feafon. In fpring and autumn it is a conftant attendant on the plough, for the fake of the worms thrown up by that inftrument.

2. The flava, or yellow wagtail, migrates in the north of England, but in Hampfhire continues the whole year. The male is a bird of great beauty: the breaft, belly, thighs, and vent-feathers, being of a moft vivid and lovely yellow: the throat is marked with fome large black fpots; above the eye is a bright yellow line: beneath that, from the bill, crofs the eye, is another of a dufky hue; and beneath the eye is a third of the fame colour: the head and upper part of the body is of an olive-green, which brightens in the coverts of the tail; the quill-feathers are dufky; the coverts of the wings olive-coloured; but the lower rows dufky, tipt with yellowifh white; the two outmoft feathers of the tail half white; the others black, as in the former. The colours of the female are far more obfcure than thofe of the male: it wants alfo thofe black fpots on the throat. It makes its neft on the ground, in corn-fields: the outfide is compofed of decayed ftems of plants, and fmall fibrous roots; the infide is lined with hair: it lays five eggs.

3. The regulus, or gold-coloured wren, is a native of Europe, and of the correfponding latitudes of Afia and America. It is the leaft of all the European birds, weighing only a fingle drachm. Its length is about four inches and an half; and the wings, when fpread out, meafure little more than fix inches. On the top of its head is a beautiful orange-coloured fpot called its *creft*, which it can hide at pleafure; the margins

Plate CLXXXII. fig. 4.

Plate CLXXXII.

Fig. 1. MOTACILLA Sutoria,
or Taylor bird.

Fig 2
MOSCHUS Moschiferus,
or Musk Animal.

Fig. 4.
MOTACILLA Regulus.

Fig. 3.
MUTILLA Occidentalis,
or Velvet Ant.

Fig. 5.
MURÆNA Helena.
The Muray.

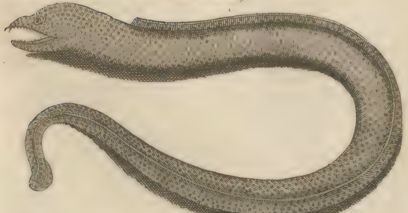


Fig. 6.
MUS Leporinus,
or Java Hare.

A. Bell Sculp.

Mote || Motte. margins of the crest are yellow, and it ends in a pretty broad black line; the sides of the neck are of a beautiful yellowish green; the eyes surrounded with a white circle; the neck and back of a dark green mixed with yellow; the breast of a dirty white; the tail composed of 12 feathers of a brown colour, an inch and an half long, but not forked. In America it associates with the titmice, running up and down the bark of lofty oaks with them, and collecting its food in their company, as if they were all of one brood. It feeds on insects lodged in their winter dormitories in a torpid state.

4. The sialis, or blue-bird, is a native of most parts of North America; and is about the bigness of a sparrow. The eyes are large; the head and upper part of the body, tail, and wings, are of a bright blue, excepting that the ends of the feathers are brown. The throat and breast are of a dirty red. The belly is white. It flies swiftly, having very long wings; so that the hawk generally pursues it in vain. It makes its nest in holes and trees; resembles our robin-red breast in its disposition, and feeds only on insects.

Plate CLXXXII. fig. 1. 5. The sutoria, or taylor-bird, is a native of the East-Indies. It is remarkable for the art with which it makes its nest, seemingly in order to secure itself and its young in the most perfect manner possible against all danger from voracious animals. It picks up a dead leaf, and sews it to the side of a living one: its slender bill is the needle, and its thread is formed of some fine fibres; the lining is composed of feathers, gossamer, and down: its eggs are white, the colour of the bird light-yellow; its length three inches; and its weight only three sixteenths of an ounce, so that the materials of the nest and its own size are not likely to draw down a habitation depending on so slight a tenure.

MOTE, in law-books, signifies court or convention; as a ward-mote, burgh-mote, swain-mote, &c.

Mote-*Bell*, or *Mot-Bell*, the bell so called, which was used by the English Saxons to call people together to the court. See Folkmote.

MOTH, in zoology. See Phalæna and Papilio.

MOTHE le Vayer (Francis de la). See Vayer.

MOTHER, a term of relation, denoting a woman who hath born a child.

Mother *of Pearl*. See Pearl.

MOTTE (Anthony Houdart de la), an ingenious Frenchman, greatly distinguished by his writings in prose and verse, and by his literary contests with many eminent persons, was born at Paris in 1672. He wrote with very different success, no man having been more praised or more criticised than he was: his literary paradoxes, his singular systems, in all branches of polite learning, and above all, his judgment upon the ancients, which, like those of Perrault, were thought disrespectful and detracting, raised him up formidable adversaries. Racine, Boileau, Rousseau, and Madam Dacier, were among the number of those who made it their business to avenge antiquity on a man who, with more wit than genius or learning, assumed a kind of dictatorial authority in the province of belles lettres. He became blind in the latter years of his life, and died in 1731: a complete edition of all his works was published in 11 vols, 8vo. in 1754; though, as has been said of our Swift, his reputation had been better consulted by reducing them to three or four.

Motion. MOTION, is defined to be the continued and successive change of place.

There are three general laws of motion.

1. That a body always perseveres in its state of rest, or of uniform motion in a right line, till by some external force it be made to change its state: for as body is passive in receiving its motion, and the direction of its motion; so it retains them, or perseveres in them without any change, till it be acted on by something external. From this law it appears why we inquire not, in philosophy, concerning the cause of the continuation of the motion or rest in bodies, which can be no other than their *inertia;* but if a motion begin, or if a motion already produced is either accelerated or retarded, or if the direction of the motion is altered, an inquiry into the power or cause that produces this change is a proper subject of philosophy. 2. The second general law of motion is, The change of motion is proportional to the force impressed, and is produced in the right line in which that force acts. When a fluid acts upon a body, as water or air upon the vanes of a mill, or wind upon the sails of a ship, the acceleration of the motion is not proportional to the whole force of those fluids, but to that part only which is impressed upon the vanes or sails, which depends upon the excess of the velocity of the fluid above the velocity which the vane or sail has already acquired; for if the velocity of the fluid be only equal to that of the vane or sail, it just keeps up with it, but has no effect either to advance or retard its motion. Regard must always be had to the direction in which the force is impressed, in order to determine the change of motion produced by it: thus, when the wind acts obliquely with respect to the direction of a ship, the change of her motion is first to be estimated in the direction of the force impressed; and thence, by a proper application of mechanical and geometrical principles, the change of the motion of the ship in her own direction is to be deduced. 3. The third general law of motion is, That action and re-action are equal, with opposite directions, and are to be estimated always in the same right line. Body not only never changes its state of itself, but resists by its *inertia* every action that produces a change in its motion: hence when two bodies meet, each endeavours to persevere in its state, and resists any change; the one acquires no new motion, but what the other loses in the same direction; nor does this last lose any force, but what the other acquires: and hence, though, by their collision, motion passes from the one to the other; yet the sum of their motions, estimated in a given direction, is preserved the same, and is unalterable by their mutual actions upon each other.

All motion may be considered absolutely or relatively. Absolute or real motion, says Mr Maclaurin, is when a body changes its place in absolute space; and relative motion, is when a body changes its place only with relation to other bodies.

From the observation of nature, every one knows that there is motion; that a body in motion perseveres in that state, till by the action of some power it is necessitated to change it; that it is not in relative or apparent motion in which it perseveres in consequence of its *inertia*, but in real or absolute motion. Thus the apparent diurnal motion of the sun and stars would

ceafe, without the leaft power or force acting upon them, if the motion of the earth was ftopt; and if the apparent motion of any ftar was deftroyed by a contrary motion impreffed upon it, the other celeftial bodies would ftill appear to perfevere in their courfe.

To make this matter ftill plainer, Mr Martin obferves, that fpace is nothing but an abfolute and infinite void, and that the place of a body is that part of the immenfe void which it takes up or poffeffes; and this place may be confidered abfolutely, or in itfelf, in which cafe it is called the *abfolute place of the body;* or elfe with regard to the place of fome other body, and then it is called the *relative* or *apparent place of the body.*

Now, as a motion is only the change of place in bodies, it is evident that it will come under the fame diftinction of abfolute and relative, or apparent. All motion is in itfelf abfolute, or the change of abfolute fpace; but when the motions of bodies are confidered and compared with each other, then are they relative and apparent only: they are relative, as they are compared to each other; and they are apparent only, infomuch that not their true or abfolute motion, but the fum or difference of the motions only is perceivable to us.

In comparing the motions of bodies, we may confider them as moving both the fame way, or towards contrary parts: in the firft cafe, the difference of motion is only perceived by us; in the latter, the fum of the motions. Thus, for example; fuppofe two fhips, A and B, fet fail from the fame port upon the fame rhumb, and that A fails at the rate of five miles *per* hour, and B at the rate of three; here the difference of the velocity (viz. two miles *per* hour) is that by which the fhip A will appear to go from the fhip B forwards, or the fhip B will appear at A to go with the fame velocity backwards, to a fpectator in either refpectively.

If the two fhips, A and B, move with the fame degree of velocity, then will the difference be nothing, and fo neither fhip will appear to the other to move at all. Hence it is, that though the earth is continually revolving about its axis; yet as all objects on its furface partake of the fame common motion, they appear not to move at all, but are relatively at reft.

If two fhips, A and B, with the degrees of velocity as above, meet each other, the one will appear to the other to move with the fum of both velocities, *viz.* at the rate of eight miles per hour; fo that in this cafe the apparent motion exceeds the true, as in the other it fell fhort of it. Hence the reafon why a perfon, riding againft the wind, finds the force of it much greater than it really is; whereas if he rides with it, he finds it lefs.

The reafon of all thefe phenomena of motion will be evident, if we confider that we muft be abfolutely at reft, if we would difcern the true or real motion of bodies about us. Thus a perfon on the ftrand will obferve the fhips failing with their real velocity. A perfon ftanding ftill will experience the true ftrength and velocity of the wind; and a perfon placed in the regions between the planets will view all their true motions, which he cannot otherwife do, becaufe in all other cafes the fpectator's own motion muft be added to or fubtracted from that of the moving body.

Motion is either *equable* or *accelerated.*

Equable motion is that by which a body paffes over equal fpaces in equal times.

Accelerated motion is that which is continually augmented or increafed, as retarded motion is that which continually decreafes; and if the increafe or decreafe of motion be equal in equal times, the motion is then faid to be equally accelerated or retarded.

Equable motion is generated by a fingle impetus or ftroke: thus the motion of a ball from a cannon is produced by the fingle action of the powder in the firft moment; and therefore the velocity it firft fets out with would always continue the fame, were it void of gravity, and to move in an unrefifting medium; which therefore would be always equable, or fuch as would carry it through the fame length of fpace in every equal part of time.

Hence we may determine the theorems for the expreffions of the time (T) the velocity (V) and the fpace (S) paffed over in equable or uniform motion very eafily thus:

If the time be given, or the fame, the fpace paffed over will be as the velocity, viz. S : V; that is, with twice the velocity, twice the fpace; with three times the velocity, three times the fpace, will be paffed over in the fame time; and fo on.

If the velocity be given, or remain the fame, then the fpace paffed over will be as the time, viz. S : T; that is, it will be greater or lefs, as the time is fo.

But if neither the time nor velocity be given or known, then will the fpace be in the compound ratio of both, viz. S : TV. Hence, in general, fince S : TV, we have $V : \frac{S}{T}$; that is, the velocity is always directly as the fpace, and inverfely as the time. And alfo $T : \frac{S}{V}$; that is, the time is as the fpace directly, and as the velocity inverfely; or, in other words, it increafes with the fpace, and decreafes with the velocity.

If, therefore, in any rectangle, one fide reprefent the time, and the other fide the velocity, it is evident that the area of the faid rectangle will reprefent the fpace paffed over by an uniform motion in that time, and with that velocity.

Accelerated motion is produced by a conftant impulfe or power, which keeps continually acting upon the body, as that of gravity which produces the motion of falling bodies; which fort of motion is conftantly accelerated, becaufe gravity every moment adds a new impulfe, which generates a new degree of velocity; and the velocity thus increafing, the motion muft be quickened each moment, or the body muft fall fafter and fafter the lower it falls.

In like manner a body thrown perpendicularly upward, as a ball from a cannon, will have its motion continually retarded, becaufe gravity acts conftantly upon it in a direction contrary to that given it by the powder; fo that its velocity upwards muft be continually diminifhed, and fo its motion as continually retarded, till at laft it be all deftroyed. The body has then attained its utmoft height, and is for a moment motionlefs; after which it begins to defcend with a velocity in the fame manner accelerated, till it comes to the earth's furface.

Since the momentum (M) of a body is compounded of the quantity of matter (Q), and the velocity (V), we have this general expreffion M=QV, for the force

force of any body A; and ſuppoſe the force of another body B be repreſented by the ſame letters in Italics, viz. $M=\mathcal{Q}V$.

Let the two bodies A and B in motion impinge on each other directly; if they tend both the ſame way, the ſum of their motions towards the ſame part will be $\mathrm{QV}+\mathcal{Q}V$. But if they tend towards contrary parts, or meet, then the ſum of their motions towards the ſame part will be $\mathrm{QV}-\mathcal{Q}V$; for ſince the motion of one of the bodies is contrary to what it was before, it muſt be connected by a contrary ſign. Or thus; becauſe, when the motion of B conſpires with that of A, it is added to it; ſo, when it is contrary, it is ſubducted from it, and the ſum or difference of the abſolute motions is the whole relative motion, or that which is made towards the ſame part. Again, this total motion towards the ſame parts, is the ſame both before and after the ſtroke, in caſe the two bodies A and B impinge on each other; becauſe, whatever change of motion is made in one of thoſe bodies by the ſtroke, the ſame is produced in the other body towards the ſame part; that is, as much as the motion of B is increaſed or decreaſed towards the ſame part by the action of A, juſt ſo much is the motion of A diminiſhed or augmented towards the ſame part by the equal re-action of B, by the third law of motion.

In bodies not elaſtic, let x be the velocity of the bodies after the ſtroke (for, ſince we ſuppoſe them not elaſtic, there can be nothing to ſeparate them after colliſion; they muſt therefore both go on together, or with the ſame celerity). Then the ſum of the motions after colliſion will be $\mathrm{Q}x+\mathcal{Q}x$; whence, if the bodies tend the ſame way, we have $\mathrm{QV}+\mathcal{Q}V=\mathrm{Q}x+\mathcal{Q}x$, or if they meet, $\mathrm{QV}-\mathcal{Q}V=\mathrm{Q}x+\mathcal{Q}x$; and accordingly $\frac{\mathrm{QV}+\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=x$, or $\frac{\mathrm{QV}-\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=x$.

If the body (B) be at reſt, then $V=o$, and the velocities of the bodies after the ſtroke will be $\frac{\mathrm{QV}}{\mathrm{Q}+\mathcal{Q}}=x$.

Thus if the bodies be equal (*viz.* $\mathrm{Q}=\mathcal{Q}$) and A with 10 degrees of velocity impinge on B at reſt; then $\frac{\mathrm{QV}}{\mathrm{Q}+\mathcal{Q}}=\frac{10}{2}=5=x$. If $\mathrm{Q}=\mathcal{Q}$, and $\mathrm{V}:V::10:6$ we have $\frac{\mathrm{QV}+\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=\frac{16}{2}=8=x$, the velocity after the ſtroke.

If the bodies are both in motion, and tend the contrary way; then when $\mathrm{Q}=\mathcal{Q}$ and $\mathrm{V}=V$, it is plain $\frac{\mathrm{QV}-\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=o=x$; that is, the bodies which meet with equal bulks and velocities will deſtroy each other's motion after the ſtroke, and remain at reſt. If $\mathrm{Q}=\mathcal{Q}$ but $\mathrm{V}:V::6:14$, then $\frac{\mathrm{QV}-\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=\frac{-8}{2}=-4=x$; which ſhews that equal bodies meeting with unequal velocities, they will, after meeting the ſtroke, both go on the ſame way which the moſt prevalent body moved before.

If the velocity $\frac{\mathrm{QV}\pm\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}$ be multiplied by the quantities of matter Q and $\mathcal{Q}$, we ſhall have $\frac{\mathrm{Q}^2\mathrm{V}\pm\mathrm{Q}\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=$ the momentum of A after the ſtroke; and $\frac{\mathrm{QV}\mathcal{Q}\pm\mathcal{Q}^2V}{\mathrm{Q}+\mathcal{Q}}=$ the momentum B; therefore $\mathrm{QV}-\frac{\mathrm{Q}^2\mathrm{V}\pm\mathrm{Q}\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=\frac{\mathrm{Q}\mathcal{Q}\mathrm{V}\pm\mathcal{Q}\mathrm{Q}V}{\mathrm{Q}+\mathcal{Q}}=\frac{\mathrm{Q}\mathcal{Q}}{\mathrm{Q}+\mathcal{Q}}\times\overline{\mathrm{V}\pm V}=$ the quantity of the motion loſt in A after the ſtroke, and conſequently is equal to what is gained in B, as may be ſhewn in the ſame manner.

But ſince a part of this expreſſion (*viz.* $\frac{\mathrm{Q}\mathcal{Q}}{\mathrm{Q}+\mathcal{Q}}$) is conſtant, the loſs of motion will ever be proportional to the other part $\mathrm{V}\pm W$. But this loſs or change of motion iu either body is the whole effect, and ſo meaſures the magnitude or energy of the ſtroke. Whereſore any two bodies, not elaſtic, ſtrike each other with a ſtroke always proportionable to the ſum of their velocities $(\mathrm{V}+V)$ if they meet, or to the difference of their velocities $(\mathrm{V}-V)$ if they tend the ſame way.

Hence, if one body (B) be at reſt before the ſtroke, then $V=o$; and the magnitude of the ſtroke will be as V; that is, as the velocity of the moving body A; and not as the ſquare of its velocity, as many philoſophers (viz. the Dutch and Italians) maintain.

In bodies perfectly elaſtic, the reſtituent power or ſpring by which the parts diſplaced by the ſtroke reſtore themſelves to their firſt ſituation, is equal to the force impreſſed, becauſe it produces an equal effect; therefore, in this ſort of bodies, there is a power of action twice as great as in the former non-elaſtic bodies; for theſe bodies not only ſtrike each other by impulſe, but likewiſe by repulſe, they always repelling each other after the ſtroke. But we have ſhewn, that the force with which non-elaſtic bodies ſtrike each other is as $\mathrm{V}\pm V$; therefore the reaction of elaſtic bodies is the ſame; that is, the velocity with which elaſtic bodies recede from each other after the ſtroke, is equal to the velocity with which they approached each other before the ſtroke. Whence if x and y be the velocities of two bodies A and B, tending the ſame way after the ſtroke, ſince $\mathrm{V}-V=y-x$, we have $x+\overline{\mathrm{V}-V}=y$; whence the motion of A after the ſtroke will be $\mathrm{Q}x$, and that of B will be $\mathcal{Q}x+\mathcal{Q}\mathrm{V}-\mathcal{Q}V$; and the ſum of theſe motions will be equal to the ſum of the motions before the ſtroke, viz. $\mathrm{Q}x+\mathrm{Q}x+\mathcal{Q}\mathrm{V}-\mathcal{Q}V=\mathrm{QV}+\mathcal{Q}V$. Whence, by reducing the equation, it will be $\mathrm{Q}x+\mathcal{Q}x=\mathrm{QV}-\mathcal{Q}\mathrm{V}+2\mathcal{Q}V$; and $x=\frac{\mathrm{QV}-\mathcal{Q}\mathrm{V}+2\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}=$ the velocity of the body A.

Again, the velocity of B is $x+\mathrm{V}-V=\frac{\mathrm{QV}-\mathcal{Q}\mathrm{V}+2\mathcal{Q}\mathrm{V}}{\mathrm{Q}+\mathcal{Q}}+\mathrm{V}-\mathrm{V}=\frac{2\mathrm{QV}-\mathrm{Q}V+\mathcal{Q}V}{\mathrm{Q}+\mathcal{Q}}$. Here we ſuppoſe the bodies tend the ſame way before the ſtroke; and it is evident from the equation above, that ſo long as $\mathrm{QV}+2\mathcal{Q}V$ is greater than $\mathcal{Q}\mathrm{V}$, the velocity (x) of A after the ſtroke will be affirmative, or the body A will move the ſame way after the ſtroke as before; but when $\mathcal{Q}V$ is greater than $\mathrm{QV}+2V\mathcal{Q}$, the velocity (x) will be negative, or the body A will be reflected back.

If the body B be at reſt, then $V=o$; and $x=\frac{\mathrm{QV}-\mathcal{Q}\mathrm{V}}{\mathrm{Q}+\mathcal{Q}}$, which ſhews the body A will go forwards or backwards, as QV is greater or leſſer than $\mathcal{Q}\mathrm{V}$, or A greater or leſſer than B.

If

Motion.

If $Q=3$, $\mathcal{Q}=$, $\mathrm{V}=10$, and $V=o$; then after the ſtroke the velocity of A will be $x=\frac{Q\mathrm{V}-\mathcal{Q}\mathrm{V}}{Q+\mathcal{Q}}=\frac{30-20}{5}=\frac{10}{5}=2$, and the velocity of B will be $y=\frac{2Q\mathrm{V}}{Q+\mathcal{Q}}=\frac{60}{5}=12$. If the bodies are both in motion, and $V=5$, the reſt is the ſame as before; then $\frac{Q\mathrm{V}-\mathcal{Q}\mathrm{V}+2\mathcal{Q}V}{Q+\mathcal{Q}}=6=$ velocity of A after the ſtroke, and $\frac{2Q\mathrm{V}-QV+\mathcal{Q}V}{Q+\mathcal{Q}}=11=$ velocity of B after the ſtroke.

If the bodies A and B move towards contrary parts, or meet each other, then will the relative velocity, to which the force of the ſtroke is proportional, be $V+V$; and ſo the velocities of A and B after the ſtroke will be x and $x+\mathrm{V}+V$; and ſo the motion of A will be Qx and $\mathcal{Q}x+\mathcal{Q}\mathrm{V}+\mathcal{Q}V$; the ſum of theſe motions in $Qx+\mathcal{Q}x+\mathcal{Q}\mathrm{V}+\mathcal{Q}V=Q\mathrm{V}-\mathcal{Q}V=$ the motion towards the ſame part before the ſtroke. Whence we have $x=\frac{Q\mathrm{V}-\mathcal{Q}\mathrm{V}-2\mathcal{Q}V}{Q+\mathcal{Q}}$, and therefore the velocity of B will be $\frac{Q\mathrm{V}-\mathcal{Q}\mathrm{V}-2\mathcal{Q}V}{Q+\mathcal{Q}}+\mathrm{V}+V=\frac{2Q\mathrm{V}+QV-\mathcal{Q}V}{Q+\mathcal{Q}}$.

If $Q\mathrm{V}+2\mathcal{Q}V$ be greater than $Q\mathrm{V}$, the motion of the body A will be backwards; otherwiſe it will go on forwards as before.

If $Q=3$, $\mathcal{Q}=2$, $\mathrm{V}=10$, and $V=5$; then will the velocity of A be $\frac{Q\mathrm{V}-\mathcal{Q}\mathrm{V}-2\mathcal{Q}V}{Q+\mathcal{Q}}=\frac{-10}{5}=-2$; and ſo the body A will go back with two degrees of velocity. The velocity of B, after the ſtroke, will be $\frac{2Q\mathrm{V}+QV-\mathcal{Q}V}{Q+\mathcal{Q}}=13$.

If the bodies are equal, that is, if $Q=\mathcal{Q}$, then $x=\frac{-2\mathcal{Q}V}{2N}=-V$; which ſhews, that when equal bodies meet each other, they are reflected back with interchanged velocities; for in that caſe alſo the velocity of B becomes $\frac{2Q\mathrm{V}}{2Q}=\mathrm{V}$.

If the bodies are equal, and one of them at reſt, as B, then ſince $Q=\mathcal{Q}$, and $V=o$, we have the velocity of A after the ſtroke $x=o$; or the body A will abide at reſt, and the velocity of B will be $=\mathrm{V}$, the velocity of A before the impulſe, as appears by the example in the figure referred to.

If ſeveral bodies B, C, D, E, F, are contiguous in a right line, and another equal body A ſtrike B with any given velocity, it ſhall loſe all its motion, or be quieſcent after the ſtroke; the body B which receives it will communicate it to C, and C to D, and D to E, and E to F; and becauſe action and re-action between the bodies B, C, D, E, are equal, as they were quieſcent before, they muſt continue ſo; but the body F, having no other body to re-act upon it, has nothing to obſtruct its motion; it will therefore move on with the ſame velocity which A had at firſt, becauſe it has all the motion of A, and the ſame quantity of matter by hypotheſis.

Let there be three bodies A, B, C, and let A ſtrike B at reſt; the velocity generated in B by the ſtroke will be $y=\frac{2Q\mathrm{V}}{Q+\mathcal{Q}}$, and ſo the momentum of B will be $\frac{2Q\mathrm{V}\mathcal{Q}}{Q+\mathcal{Q}}=\mathcal{Q}y$. With this momentum B will ſtrike C at reſt and contiguous to it; the velocity generated in C will be $\frac{2\mathcal{Q}y}{\mathcal{Q}+C}$; and its momentum will be $\frac{2\mathcal{Q}yC}{\mathcal{Q}+C}=\frac{2QC}{\mathcal{Q}+C}\times\frac{2Q\mathrm{V}}{Q+\mathcal{Q}}=\frac{4Q\mathrm{V}\mathcal{Q}C}{Q\mathcal{Q}+QC+\mathcal{Q}^2+\mathcal{Q}C}$.

Motion ‖ Motteux.

If now we ſuppoſe B a variable quantity, while A and C remain the ſame, we ſhall find what proportion it muſt have to each of them, in order that the momentum of C may be a maximum, or the greateſt poſſible, by putting the fluxion thereof equal to nothing; that is, $\frac{4Q^2C^2\mathrm{V}\dot{\mathcal{Q}}-4QC\mathcal{Q}^2\dot{\mathcal{Q}}}{(QC+Q\mathcal{Q}+\mathcal{Q}C+\mathcal{Q}^2)^2}=o$; whence we get $QC-\mathcal{Q}\mathcal{Q}=o$, and ſo $QC=\mathcal{Q}\mathcal{Q}$; conſequently $Q:\mathcal{Q}::\mathcal{Q}:C$, or A : B :: B : C; that is, the body B is a geometrical mean between A and C. Hence if there be any number (n) of bodies in a geometrical ratio (r) to each other, and the firſt be A, the ſecond will be rA, the third r^2A, and ſo on to the laſt, which will be r^{n-1}A.

Alſo, the velocity of the firſt being V, that of the ſecond will be $\frac{2\mathrm{V}}{1+r}$ (for $\frac{2Q\mathrm{V}}{Q+\mathcal{Q}}$ is here $=\frac{2A\mathrm{V}}{A+rA}=\frac{2\mathrm{V}}{1+r}$) that of the third $\frac{4\mathrm{V}}{\overline{1+r}^2}$, that of the fourth $\frac{8\mathrm{V}}{\overline{1+r}^3}$, and ſo on to the laſt, which will be $\left(\frac{2}{1+r}\right)^{n-1}\mathrm{V}$.

The momentum of the firſt will be AV, that of the ſecond $\frac{2r\mathrm{AV}}{1+r}$, that of the third $\frac{4r^2\mathrm{AV}}{\overline{1+r}^2}$, that of the fourth $\frac{8r^3\mathrm{AV}}{\overline{1+r}^3}$, and ſo on to the laſt, which will be $\left(\frac{2r}{1+r}\right)^{n-1}\mathrm{AV}$.

To give an example of this theorem; if $n=100$, and $r=2$, then will the firſt body A be to the laſt r^{n-1}A, as 1 to 633825300000000000000000000000, nearly; and its velocity to that of the laſt nearly as 271022000000000000 to 1: laſtly, the momentum of the firſt to that of the laſt will be nearly as 1 to 2338480000000.

If the number (n) of bodies be required, and the ratio of the momenta of the firſt and laſt be given as 1 to M, and the ratio of the ſeries r given alſo; then, putting $\frac{2r}{1+r}=\mathrm{R}$, we have the momentum of the laſt body expreſſed by $\left(\frac{2r}{1+r}\right)^{n-1}=\mathrm{M}=\mathrm{R}^{n-1}$; therefore the logarithm of M ($l.$ M) is equal to the logarithm of R ($l.$ R) multiplied by the power $n-1$; that is, $l.\,\mathrm{M}=\overline{n-1}\times l.\,\mathrm{R}$; conſequently $\frac{l.\,\mathrm{M}}{l.\,\mathrm{R}}+1=n$, the number of bodies required.

MOTTEUX (Peter), a French gentleman, born and educated at Rouen in Normandy. Coming over to England on account of the perſecution of the Proteſtants, he became a conſiderable trader in London, kept an Eaſt-India warehouſe in Leadenhall-ſtreet, and had a genteel place in the general poſt-office, relating to foreign letters, being maſter of ſeveral languages.

guages. He was a man of wit and humour; and acquired so perfect a mastery of the English language, that he not only was qualified to oblige the world with a very good translation of Don Quixote, but also wrote several songs, prologues, epilogues, &c. and what was still more extraordinary, became a very eminent dramatic writer in a language to which he was not a native. He was at last, in the year 1718, found dead in a disorderly house, on his birth-day, when he completed his 58th year.

MOTTO, in armoury, a short sentence or phrase, carried in a scroll, generally under, but sometimes over, the arms; sometimes alluding to the bearing, sometimes to the name of the bearer, and sometimes containing whatever pleases the fancy of the deviser.

MOVEABLE, in general, denotes any thing capable of being moved.

Moveable *Subject*, in Scots law, any thing that moves itself, or can be moved; in contradistinction to immoveable or heritable subjects, as lands, houses, &c.

MOVEMENT, in mechanics, a machine that is moved by clock-work. See Clock and Watch.

Perpetual Movement. Many have attempted to find a perpetual movement, but without success; and there is reason to think, from the principles of mechanics, that such a movement is impossible: for tho', in many cases of bodies acting upon one another, there is a gain of absolute motion, yet the gain is always equal in opposite directions; so that the quantity of direct motion is never increased.

To make a perpetual movement, it appears necessary that a certain system of bodies, of a determined number and quantity, should move in a certain space for ever, and in a certain way and manner; and for this there must be a series of actions returning in a circle, otherwise the movement will not be perpetual; so that any action by which the absolute quantity of force is increased, of which there are several sorts, must have its corresponding counter-action, by which the gain is destroyed, and the quantity of force restored to its first state.

Thus by these actions there will never be any gain of direct force to overcome the friction and resistance of the medium; so that every motion being diminished by these resistances, they must at length languish and cease.

MOVING plants. See Hedysarum, Tremella, and Mimosa.

MOULD, or Mold, in the mechanic arts, a cavity cut with a design to give its form or impression to some softer matter applied therein; of great use in Sculpture, Foundery, &c. See these articles.

Mould, in agriculture, a loose kind of earth, everywhere obvious on the surface of the ground, called also *natural* or *mother earth;* by some also *loam.* For an account of the nature and properties of this earth, see Agriculture, Part I.

MOULDINESS, a term applied to bodies which corrupt in the air, from some hidden principle of humidity therein; and whose corruption shews itself by a certain white down or lanugo on their surface, which, viewed through a microscope, appears like a kind of meadow, out of which arise herbs and flowers, some only in the bud, others full-blown, and others decayed; each having its root, stalk, and other parts. See Mucor.

MOULDING, any thing cast in a mould, or that seems to have been so though in reality it were cut with a chisel or the ax.

Mouldings, in architecture, projectures beyond the naked wall, column, wainscot, &c. the assemblage of which forms corniches, door-cases, and other decorations of Architecture. See that article.

MOULIN (Charles du), a celebrated civilian, and one of the most learned men of the 16th century, was born of a considerable family at Paris in 1500, and acquired great reputation by his skill in the law. He published many works, which have been collected together, and printed in five volumes folio; and are justly considered as the most excellent works that France has produced on the subject of civil law. He died at Paris in 1566.

Moulin (Peter du), a Protestant divine, believed to be of the same family with the former, was born in 1568. He taught philosophy at Leyden; and afterwards became chaplain to the princess of Navarre. At the king of England's desire he came hither in 1615, and prepared a plan for the union of the Protestant churches. The university of Leyden offered him a professorship of divinity in 1619: but he refused it, and presided at the synod held by the Calvinists at Alais in 1620. Some time after, being informed by Mr Drelincourt that the French king resolved to have him thrown into prison, he retired to Sedan, where the duke de Bouillon made him professor of divinity, and minister in ordinary. He was employed by the Calvinists in the most important affairs; and died at Sedan in 1658. His principal works are, 1. The anatomy of Arminianism. 2. A treatise on repentance, and the keys of the church. 3. The Capuchine, or the history of those monks. 4. The buckler of faith, or a defence of the reformed churches. 5. The judge of controversies and traditions. 6. The anatomy of the mass. 7. The novelty of Popery.

Peter du Moulin, his eldest son, was chaplain to Charles II. of England, and prebendary of Canterbury, where he died in 1684, aged 84. He wrote, 1. The peace of the soul, in French. 2. *Clamor regii sanguinis;* which Milton, by mistake, attributed to Alexander Morus. 3. A defence of the Protestant religion, in English.

MOULINET, is used, in mechanics, to signify a roller, which, being crossed with two levers, is usually applied to cranes, capstans, and other sorts of engines of the like nature, to draw ropes, and heave up stones, &c.

Moulinet is also a kind of turnstile, or wooden cross, which turns horizontally upon a stake fixed in the ground; usually placed in passages to keep out horses, and to oblige passengers to go and come one by one. These moulinets are often set near the outworks of fortified places at the sides of the barriers, through which people pass on foot.

MOUND, a term used for a bank or rampart, or other fence, particularly that of earth.

Mound, in heraldry, a ball or globe with a cross upon it, such as our kings are usually drawn with, holding it in their left hand, as they do the sceptre in the right.

Mount. MOUNT, an elevation of earth, called alſo *mountain*. See MOUNTAIN.

MOUNT *of Piety*, certain funds or eſtabliſhments in Italy, where money is lent out on ſome ſmall ſecurity. There were alſo mounts of piety in England, raiſed by contribution for the benefit of people ruined by the extortions of the Jews.

MOUNTAIN, a part of the earth riſing to a conſiderable height above the level of the ſurface thereof.

The origin of mountains is variouſly aſſigned by philoſophers: ſome will have them coeval with the world, and created along with it; others, among whom is Dr Burnet, will have them to take their riſe from the deluge, urging that the extreme irregularity and diſorder viſible in them, plainly ſhews they do not come immediately out of the hand of God, but are the wrecks of the old world, broken into the abyſs. See DELUGE.

Others again allege from hiſtory, that the roots of many hills being eaten away, the hills themſelves have ſubſided and ſunk into plains; whence they conclude, that where the corruption is natural, the generation is ſo too. It appears certain to many, that ſome mountains muſt have generated gradually, and have grown up in proceſs of time, from the ſea-ſhells, &c. found in them, which they ſuppoſe may be accounted for from a violent wind blowing the ſand, &c. into huge heaps, which were made into a maſs by the rain, &c. The origin of mountains, in the opinion of Mr Ray, ſeems to have been from exploſions by means of ſubterraneous fires; and he thinks it very probable, that they all have vaſt hollows beneath them: and that this might have been the means uſed at the creation to make the dry land appear, he thinks no way diſſonant to reaſon, ſince hiſtory proves that fires have raged in ſubterraneous caverns under the ſeas; and there is no natural impoſſibility in fire's ſubſiſting in ſuch caverns, even when the earth was all over covered with water, as at the firſt creation.

Mountains appear to many to be defects and blemiſhes in the earth; but they are truly of the utmoſt uſe and neceſſity to the well-being both of man and other animals. They ſerve as ſcreens to keep off the cold and nipping blaſts of the northern and eaſtern winds; they ſerve for the production of a great number of vegetables and minerals, which are not found in any other ſoil; the long ridges and chains of lofty and topping mountains, being generally found to run from eaſt to weſt, ſerve to ſtop the evagation of the vapours towards the poles, without which they would all run from the hot countries, and leave them deſtitute of rain. Mr Ray adds, that they condenſe theſe vapours, like alembic heads, into clouds; and ſo, by a kind of external diſtillation, give origin to ſprings and rivers; and by amaſſing, cooling, and conſtipating them, turn them into rain, and by that means render the fervid region of the torrid zone habitable. He farther adds, that many creatures cannot live but in particular ſituations; and even the tops of the higheſt and the coldeſt mountains are the only places where ſome creatures, as well birds as quadrupeds, will live.

M. Buffon remarks, that the higheſt mountains of the world, as well as the largeſt, are ſituated in the torrid zone; and the nearer we approach the equator, the greater are the inequalities on the earth's ſurface. "A ſhort enumeration of mountains and iſlands (ſays he) will be ſufficient to eſtabliſh this point.—In America, the Cordileras, which are the higheſt mountains in the world, lie preciſely under the equator; and they extend on both ſides a conſiderable way beyond the tropic circles. The higheſt mountains of the Moon, of Monomotapa, and the great and little Atlas in Africa, lie either under or very near the equator. In Aſia, mount Caucaſus, the chain of which, under different names, runs into China, and through this whole extent, lies nearer the equator than the poles. In Europe, the Pyrenees, the Alps, and the mountains of Greece, which form one chain, are ſtill leſs diſtant from the equator than the pole.

"Theſe chains of mountains of which we have given an enumeration, are higher and of greater extent, both in length and breadth, than thoſe of more northern countries. With regard to their direction, the Alps form a continued chain which runs acroſs the whole continent from Spain to China. They commence on the ſea-coaſt of Galicia, join the Pyrenees, traverſe France by Vivares and Auvergne, run through Italy, and ſtretch into Germany above Dalmatia, until they reach Macedonia; from thence they join the mountains of Armenia, the Caucaſus, the Taurus, the Imaus, and at laſt terminate on the coaſt of Tartary. Mount Atlas in the ſame manner traverſes the whole continent of Africa, from the kingdom of Fez to the Straits of the Red Sea. The mountains of the moon have likewiſe the ſame direction; but the mountains of America have an oppoſite direction. The vaſt chains of Cordileras, and other mountains, run more from ſouth to north than from eaſt to weſt."

This aſſertion concerning the magnitude and height of mountains, is no doubt neceſſary for the ſupport of his theory of the earth *; but it is by no means agreeable to fact. The mountains of the moon, though much nearer the equator than the Alps, are not, by all accounts, equal to them in ſize; one of the peaks of the Alps, named *Mont Blanc*, being reckoned the higheſt point of land in Europe, Aſia, or Africa. According to ſome late computations, this peak is more than 800 feet higher than mount Ætna would be with Veſuvius ſet on its top; ſo that we may reckon it little inferior to the higheſt mountains even in America. In Mr Forſter's account of the Southern Thule alſo, he tells us of an exceeding high mountain ſeen on that iſland, and which was thought to be little leſs than two miles perpendicular; and yet this iſland lies in a very conſiderable ſouth latitude: ſo that the height of mountains ſeems by no means to be in proportion to the vicinity of the equator or torrid zone.

* See *Earth*.

The moſt remarkable mountain in the world for ſhape, is that called the *needle mountain*, or the *inacceſſible mountain*, in Dauphiny.—This is a vaſt hill, placed as it were bottom upwards, or ſet on its ſummit on the earth, with its broad baſe elevated in the air; it is but about 1000 paces in circumference at bottom, and above 2000 at the top. On the centre of the plain at the top there ſtands another ſmall and very narrow, but very high hill. It obtained its name from

from the ſuppoſed impoſſibility of aſcending it, on account of its projection outwards. Some hardy perſons, however, once ventured to climb it; and found at the top a number of the chamois, animals by no means qualified for climbing, and which doubtleſs had never either aſcended or deſcended the mountain, and which muſt be ſuppoſed to have bred there for many ages; though it is very difficult to account for their coming there.

The difficulty and danger of aſcending to the tops of mountains, proceeds not from the thinneſs of the air as has been commonly reported; but the reaſon is, that they riſe with ſuch a rugged and precipitate aſcent, that they are utterly inacceſſible. In ſome places they appear like a great wall of 600 or 700 feet high; in others, there ſtick out enormous rocks, that hang upon the brow of the ſteep, and every moment threaten deſtruction to the traveller below.

In this manner almoſt all the tops of the higheſt mountains are bare and pointed. And this naturally proceeds from their being ſo continually aſſaulted by thunders and tempeſts. All the earthy ſubſtances with which they might have been once covered, have for ages been waſhed away from their ſummits; and nothing is left remaining but immenſe rocks, which no tempeſt has hitherto been able to deſtroy.

Nevertheleſs, time is every day and every hour making depredations; and huge fragments are ſeen tumbling down the precipiece, either looſened from the ſummit by the froſt or rains, or ſtruck down by lightning. Nothing can exhibit a more terrible picture than one of theſe enormous rocks, commonly larger than an houſe, falling from its height with a noiſe louder than thunder, and rolling down the ſide of the mountain. Dr Plot tells us of one in particular, which being looſened from its bed, tumbled down the precipice, and was partly ſhattered into a thouſand pieces. Notwithſtanding, one of the largeſt fragments of the ſame, ſtill preſerving its motion, travelled over the plain below, croſſed a rivulet in the midſt, and at laſt ſtopped on the other ſide of the bank! Theſe fragments, as was ſaid, are often ſtruck off by lightning, and ſometimes undermined by rains; but the moſt uſual manner in which they are diſunited from the mountain, is by froſt: the rains inſinuating between the interſtices of the mountain, continue there until there comes a froſt; and then, when converted into ice, the water ſwells with an irreſiſtible force, and produces the ſame effect as gun-powder, ſplitting the moſt ſolid rocks, and thus ſhattering the ſummits of the mountain.

But not rocks alone, but whole mountains, are, by various cauſes, diſunited from each other. We ſee, in many parts of the Alps, amazing clefts, the ſides of which ſo exactly correſpond with the oppoſite, that no doubt can be entertained of their having been once joined together. At Cajeta, in Italy, a mountain was ſplit in this manner by an earthquake; and there is a paſſage opened through it, that appears as if elaborately done by the induſtry of man. In the Andes theſe breaches are frequently ſeen. That at Thermopyle, in Greece, has been long famous. The mountain of the Troglodytes, in Arabia, has thus a paſſage through it: and that in Savoy, which nature began, and which Victor Amadeus completed, is an inſtance of the ſame kind.

We have accounts of ſome of theſe diſruptions, immdiately after their happening. "In the month of June, in the year 1714, a part of the mountain of Diableret, in the diſtrict of Valais, in France, ſuddenly fell down, between two and three o'clock in the afternoon, the weather being very calm and ſerene. It was of a conical figure, and deſtroyed 55 cottages in the fall. Fifteen perſons, together with about 100 beaſts, were alſo cruſhed beneath its ruins, which covered an extent of a good league ſquare. The duſt it occaſioned inſtantly covered all the neighbourhood in darkneſs. The heaps of rubbiſh were more than 300 feet high. They ſtopped the current of a river that ran along the plain, which now is formed into ſeveral new and deep lakes. There appeared, through the whole of this rubbiſh, none of thoſe ſubſtances that ſeemed to indicate that this diſruption had been made by means of ſubterraneous fires. Moſt probably, the baſe of this rocky mountain was rotted and decayed; and thus fell, without any extraneous violence." In the ſame manner, in the year 1618, the town of Pleurs, in France, was buried beneath a rocky mountain, at the foot of which it was ſituated.

Theſe accidents, and many more that might be enumerated of the ſame kind, have been produced by various cauſes: by earthquakes, as in the mountain at Cajeta; or by being decayed at the bottom, as at Diableret. But the moſt general way is, by the foundation of one part of the mountain being hollowed by waters, and thus wanting a ſupport, breaking from the other. Thus it generally has been found in the great chaſms in the Alps; and thus it almoſt always is known in thoſe diſruptions of hills which are known by the name of *land-ſlips*. Theſe are nothing more than the ſliding down of an higher piece of ground, diſrooted from its ſituation by ſubterraneous inundations, and ſettling itſelf upon the plain below.

There is not an appearance in all nature that ſo much aſtoniſhed our anceſtors as theſe land-ſlips. In fact, to behold a large upland, with its houſes, its corn, and cattle, at once looſened from its place, and floating as it were upon the ſubjacent water; to behold it quitting its ancient ſituation, and travelling forward like a ſhip, in queſt of new adventures; this is certainly one of the moſt extraordinary appearances that can be imagined; and, to a people ignorant of the powers of nature, might well be conſidered as a prodigy. Accordingly, we find all our old hiſtorians mentioning it as an omen of approaching calamities. In this more enlightened age, however, its cauſe is very well known; and, inſtead of exciting ominous apprehenſions in the populace, it only gives riſe to ſome very ridiculous law-ſuits among them, about whoſe the property ſhall be; whether the land which has thus ſlipt, ſhall belong to the original poſſeſſor, or to him upon whoſe grounds it has encroached and ſettled. What has been the determination of the judges is not ſo well known; but the circumſtances of the ſlips themſelves have been minutely enough and exactly deſcribed.

In the lands of Slatberg, in the kingdom of Ireland, there ſtood a declivity gradually aſcending for near half a mile. In the year 1713, and on the 10th of March, the

 the inhabitants perceived a crack on its ſide, ſomewhat like a furrow made with a plough, which they imputed to the effects of lightning, as there had been thunder the night before. However, on the evening of the ſame day, they were ſurpriſed to hear an hideous confuſed noiſe iſſuing all round from the ſide of the hill; and their curioſity being raiſed, they reſorted to the place. There, to their amazement, they found the earth for near five acres all in gentle motion, and ſliding down the hill upon the ſubjacent plain. This motion continued the remaining part of the day, and the whole night: nor did the noiſe ceaſe during the whole time; proceding, probably, from the attrition of the ground beneath. The day following, however, this ſtrange journey down the hill ceaſed entirely; and above an acre of the meadow below was found covered with what before compoſed a part of the declivity.

However, theſe ſlips, when a whole mountain's ſide ſeems to deſcend, happen but very rarely. There are ſome of another kind, however, much more common; and, as they are always ſudden, much more dangerous. Theſe are ſnow-ſlips, well known, and greatly dreaded by travellers. It often happens, that when ſnow has long been accumulated on the tops and on the ſides of mountains, it is borne down the precipice either by means of tempeſts or its own melting. At firſt, when looſened, the volume in motion is but ſmall; but it gathers as it continues to roll, and, by the time it has reached the habitable parts of the mountain, it is generally grown of enormous bulk. Wherever it rolls, it levels all things in its way; or buries them in unavoidable deſtruction. Inſtead of rolling, it ſometimes is found to ſlide along from the top; yet even thus it is generally as fatal as before. Nevertheleſs, we have had an inſtance, a few years ago, of a ſmall family in Germany that lived for above a fortnight beneath one of theſe ſnow-ſlips. Although they were buried during that whole time in utter darkneſs, and under a bed of ſome hundred feet deep, yet they were luckily taken out alive, the weight of the ſnow being ſupported by a beam that kept up the roof; and nouriſhment being ſupplied them by the milk of a ſhe-goat that was buried under the ſame ruin.

Attraction of MOUNTAINS. This is a late diſcovery, and a very conſiderable confirmation of Sir Iſaac Newton's theory of univerſal gravity. According to the Newtonian ſyſtem, an attractive power is not only exerted between thoſe large maſſes of matter which conſtitute the ſun and planets; but likewiſe between all comparatively ſmaller bodies, and even between the ſmalleſt particles of which they are compoſed. Agreeably to this hypotheſis, a heavy body, which ought to gravitate or tend toward the centre of the earth, in a direction perpendicular to its ſurface, ſuppoſing the ſaid ſurface to be perfectly even and ſpherical, ought likewiſe, though in a leſs degree, to be attracted and tend towards a mountain placed on the earth's ſurface: ſo that a plumb-line, for inſtance, of a quadrant, hanging in the neighbourhood of ſuch a mountain, ought to be drawn from a perpendicular ſituation, in conſequence of the attractive power of the quantity of matter of which it is compoſed, acting in a direction different from that exerted by the whole maſs of matter in the earth, and with a proportionably inferior degree of force.

Though Sir Iſaac Newton had long ago hinted at an experiment of this kind; and had remarked, that "a mountain of an hemiſpherical figure, three miles high and ſix broad, would not, by its attraction, draw the plumb-line two minutes out of the perpendicular (A):" yet no attempt to aſcertain this matter, by actual experiment, was made till about the year 1738; when the French academicians, particularly Meſſrs Bouguer and Condamine, who were ſent to Peru to meaſure a degree under the equator, attempted to diſcover the attractive power of Chimboraço, a mountain in the province of Quito. According to their obſervations, which were however made under circumſtances by no means favourable to an accurate ſolution of ſo nice and difficult a problem, the mountain Chimboraço exerted an attraction equal to eight ſeconds. Though this experiment was not perhaps ſufficient to prove ſatisfactorily even the reality of an attraction, much leſs the preciſe quantity of it; yet it does not appear that any ſteps had been ſince taken to repeat it.

Through the munificence of his Britannic majeſty, the royal ſociety were enabled to undertake the execution of this delicate and important experiment; the aſtronomer royal was choſen to conduct it. After various inquiries, the mountain Schehallien, ſituated nearly in the centre of Scotland, was pitched upon as the moſt proper for the purpoſe that could be found in this iſland. The obſervations were made by taking the meridian zenith diſtances of different fixed ſtars, near the zenith, by means of a zenith ſector of ten feet radius; firſt on the ſouth, and afterwards on the north ſide of the hill, the greateſt length of which extended in an eaſt and weſt direction.

It is evident, that if the maſs of matter in the hill exerted any ſenſible attraction, it would cauſe the plumb-line of the ſector, through which an obſerver viewed a ſtar in the meridian, to deviate from its perpendicular ſituation, and would attract it contrary ways at the two ſtations, thereby doubling the effect. On the ſouth ſide the plummet would be drawn to the northward, by the attractive power of the hill placed to the northward of it: and on the north ſide, a contrary and equal deflection of the plumb-line would take place, in conſequence of the attraction of the hill, now to the ſouthward of it. The apparent zenith diſtances of the ſtars would be affected contrarywiſe; thoſe being increaſed at the one ſtation which were diminiſhed at the other: and the correſpondent quantities of the deflection of the plumb-line would give the obſerver the ſum of the contrary attractions of the hill, acting on the plummet at the two ſtations; the half of which will of courſe indicate the attractive power of the hill.

The various operations requiſite for this experiment laſted about four months; and from them it appears, that the ſum of the two contrary attractions of the mountain Schehallien, in the two temporary obſervations which were ſucceſſively fixed half-way up the hill (where the effect of its attraction would be greateſt) was equal to 11″. 6.—From a rough computation, founded on the known law of gravitation, and

A By a very eaſy calculation it is found that ſuch a mountain would attract the plumb-line 1′ 18″ from the perpendicular.

and on an aſſumption that the denſity of the hill is equal to the mean denſity of the earth; it appears that the attraction of the hill ſhould amount to about the double of this quantity. From thence it was inferred, that the denſity of the hill is only about half the mean denſity of the earth. It does not appear, however, that the mountain Schehallien has ever been a volcano, or is hollow; as it is extremely ſolid and denſe, and ſeemingly compoſed of an entire rock.

The inference drawn from theſe experiments may be reduced to the following:

" 1. It appears, that the mountain Schehallien exerts a ſenſible attraction; therefore, from the rules of philoſophiſing, we are to conclude, that every mountain, and indeed every particle of the earth, is endued with the ſame property, in proportion to its quantity of matter.

" 2. The law of the variation of this force, in the inverſe ratio of the ſquares of the diſtances, as laid down by Sir Iſaac Newton, is alſo confirmed by this experiment. For if the force of attraction of the hill had been only to that of the earth as the matter in the hill to that of the earth, and had not been greatly increaſed by the near approach to its centre, the attraction thereof muſt have been wholly inſenſible. But now, by only ſuppoſing the mean denſity of the earth to be double to that of the hill, which ſeems very probable from other conſiderations, the attraction of the hill will be reconciled to the general law of the variation of attraction in the inverſe duplicate ratio of the diſtances, as deduced by Sir Iſaac Newton from the compariſon of the motion of the heavenly bodies with the force of gravity at the ſurface of the earth; and the analogy of nature will be preſerved.

" 3. We may now, therefore, be allowed to admit this law, and to acknowledge, that the mean denſity of the earth is at leaſt double of that at the ſurface; and conſequently that the denſity of the internal parts of the earth is much greater than near the ſurface. Hence alſo, the whole quantity of matter in the earth will be at leaſt as great again as if it had been all compoſed of matter of the ſame denſity with that at the ſurface; or will be about four or five times as great as if it were all compoſed of water.—This concluſion, Mr Maſkelyne adds, is totally contrary to the hypotheſis of ſome naturaliſts, who 'ſuppoſe the earth to be only a great hollow ſhell of matter; ſupporting itſelf from the property of an arch, with an immenſe vacuity in the midſt of it.' But, were that the caſe, the attraction of mountains, and even ſmaller inequalities in the earth's ſurface, would be very great, contrary to experiment, and would affect the meaſures of the degrees of the meridian much more than we find they do; and the variation of gravity, in different latitudes, in going from the equator to the poles, as found by pendulums, would not be near ſo regular as it has been found by experiment to be.

" 4. As mountains are, by theſe experiments, found capable of producing ſenſible deflections of the plumb-lines of aſtronomical inſtruments; it becomes a matter of great importance, in the menſuration of degrees in the meridian, either to chooſe places where the irregular attractions of the elevated parts may be ſmall; or where, by their ſituation, they may compenſate or counteract the effects of each other."

For meaſuring the heights of mountains, ſee the article BAROMETER, and the ſame in the APPENDIX.

MOUSE, in zoology. See MUS.

MOUSE-*Ear*, in botany. See HIERACHIUM.

MOUSE-*Tail*. See MYOSURUS.

Dor-MOUSE. See SOREX.

MOUSUL, or MOSUL, a town of Turkey in Aſia, ſeated on the weſtern bank of the river Tigris, nearly oppoſite to the place where Nineveh formerly ſtood. It is a large place, ſurrounded with high walls; but the houſes are ill-built, and in ſeveral places gone to ruin; however, it has a ſtrong caſtle and a citadel. It is a place of great trade, particularly in cloth and all ſorts of cottons and ſilks. At ſome diſtance from Mouſul is a moſque, in which they pretend the prophet Jonah lies. The inhabitants are generally Mahometans; but there are a great number of Neſtorian Chriſtians. It was beſieged in vain by the Perſians in 1743. E. Lon. 41. 45. N. Lat. 35. 30.

MOUTH, in anatomy, a part of the face, conſiſting of the lips, the gums, the inſides of the cheeks, the palate, the ſalival glands, the os hyoides, the uvula, and the tonſils; which ſee under the article ANATOMY.

Mr Derham obſerves, that the mouth in the ſeveral ſpecies of animals is nicely adapted to the uſes of ſuch a part, and well ſized and ſhaped for the formation of ſpeech, the gathering and receiving of food, the catching of prey, &c. In ſome creatures it is wide and large, in others little and narrow; in ſome it is formed with a deep inciſure into the head, for the better catching and holding of prey, and more eaſy comminution of hard, large, and troubleſome food; and in others with a ſhorter inciſure, for the gathering and holding of herbaceous food. In birds, it is neatly ſhaped for piercing the air; hard and horny, to ſupply the want of teeth; hooked, in the rapacious kind, to catch and hold their prey; long and ſlender in thoſe that have their food to grope for in mooriſh places; and broad and long in thoſe that ſearch for it in the mud. Nor is the mouth leſs remarkable in inſects: in ſome it is forcipated, to catch, hold, and tear the prey; in others aculeated, to pierce and wound animals, and ſuck their blood; in others, ſtrongly rigid, with jaws and teeth, to gnaw and ſcrape out their food, carry burdens, perforate the earth, nay the hardeſt wood, and even ſtones themſelves, for houſes and neſts for their young.

MOXA, alſo called *artemiſia Chinenſis*. *Moxa*, or *mugwort* of China. It is a ſoft lanuginous ſubſtance, prepared in Japan from the young leaves of a ſpecies of mugwort, by beating them together when thoroughly dried, and rubbing them betwixt the hands, till only the fine fibres are left.

The down on the leaves of mullein, cotton, hemp, &c. do as well as moxa.

In the Eaſtern countries it is uſed by burning it on the ſkin: a little cone of the moxa is laid upon the part, previouſly moiſtened, and ſet on fire at the top; it burns down with a temperate glowing heat, and produces a dark-coloured ſpot, the exulceration of which is promoted by applying a little garlic; the ulcer is left to diſcharge, or is ſoon healed, according to the intention in uſing the moxa. See ARTEMISIA.

MOYLE (Walter), a learned Englifh writer in the 18th century, defcended of a good family in Cornwall, where he was born in 1672. He was fent to Oxford, and thence removed to the temple; where he applied himfelf chiefly to the general, and more noble parts of the law, fuch as led him to the knowledge of the conftitution of the Englifh government. In 1697 he had a fhare with Mr Trenchard in writing a pamphlet, intitled, "An argument fhewing that a ftanding army is inconfiftent with a free government, and abfolutely deftructive to the conftitution of the Englifh monarchy." He tranflated Xenophon's difcourfe upon improving the ftate of Athens. He was for fome time member of parliament, in which he always acted an honourable part; applying himfelf to the improvement and regulation of trade, and the employment of the poor, which has fo near a connection with trade. He afterwards retired to his feat at Bake in Cornwall, where he applied himfelf with vigour to his ftudies, and died in 1721. In 1726, his works were printed at London, in 2 vols 8vo.

MUCILAGE, in pharmacy, is in general any vifcid or glutinous liquor.

Mucilage, alfo imports the liquor which principally ferves to moiften the ligaments and cartilages of the articulations; and is fupplied by the mucilaginous glands.

MUCOR, in botany, a genus of the order of fungi, belonging to the cryptogamia clafs of plants. There are 12 fpecies; the moft remarkable of which are, 1. The fpærocephalus, or grey round-headed mucor, growing upon rotten wood, and fometimes upon decayed plants and moffes. The ftalks of this are generally black; about a line in height, bearing each at the top a fpherical ball about the fize of a pin's head; its coat or rind is covered with a grey powder, and containing within a black or fufcous fpongy down. The coat burfts with a ragged, irregular margin. 2. The lichenoides, or little, black, pin headed mucor. This fpecies grows in groups near to each other, in chafms of the barks of old trees, and upon old park-pales. The ftalks are black, about two lines in height; bearing each a fingle head, fometimes a double or treble one, of the fize of muftard or poppy feeds, of a roundifh figure at firft, but when burft often flattifh or truncated, and of a black colour. The internal powdered down is black, with a tinge of green. 3. The mucedo, or common grey mould, grows on bread, fruits, plants, and other fubftances in a putrid ftate. It grows in clufters; the ftalks a quarter of an inch high, pellucid, hollow, and cylindrical; fupporting each a fingle globular head, at firft tranfparent, afterwards dark grey; which burfts with elaftic force, and ejects fmall round feeds difcoverable by the microfcope. 4. The glaucus, or grey clufter-headed mould, is found on rotten apples, melons, and other fruits; as alfo upon decayed wood, and the ftalks of wheat. Thefe are of a pellucid grey colour; the ftalks generally fingle, fupporting a fpherical ball, which, when magnified, appears to be compounded of numerous, fine, moniliform, necklace-like radii. 5. The cruftaceus, or fingered mould, is frequent upon corrupted food of various kinds. It is of a white aqueous colour; the ftalks fingle, each fupporting at the top four or five necklace-like radii, diverging from the fame point or centre. 6. The fepticus, or yellow frothy mucor, is found on the leaves of plants, fuch as ivy and beech, &c. fometimes upon dry fticks, and frequently upon the tan or bark in hot-houfes. It is of no certain fize or figure, but of a fine yellow colour, and a fubftance refembling at firft cream beat up into froth. In the fpace of 24 hours it acquires a thin filmy coat, becomes dry, and full of a footy powder adhering to downy threads. The feeds under the microfcope appear to be globular. Haller ranks it under a new genus, which he terms *fuligo;* the characters of which are, that the plants contained under it are foft, and like butter at firft, but foon change into a black footy powder.

MUCUS, a mucilaginous liquor fecreted by certain glands, and ferving to lubricate many of the internal cavities of the body. In its natural ftate it is generally limpid and colourlefs; but, from certain caufes, will often affume a thick confiftence and whitifh colour like pus. As it is fometimes of very great importance in medicine to diftinguifh thefe two fluids from each other, this was lately propofed as the fubject of a prize-difputation by the Æfculapian Society of Edinburgh. The prize was gained by Mr Charles Darwin ftudent of medicine from Litchfield. The conclufions drawn from his experiments were,

1. Pus and mucus are both foluble in the vitriolic acid, though in very different proportions, pus being by far leaft foluble.

2. The addition of water to either of thefe compounds decompofes it. The mucus thus feparated, either fwims in the mixture, or forms large flocculi in it; whereas the pus falls to the bottom, and forms, on agitation, an uniform turbid mixture.

3. Pus is diffufible through a diluted vitriolic acid, though mucus is not. The fame alfo occurs with water, or with a folution of fea falt.

4. Nitrous acid diffolves both pus and mucus. Water added to the folution of pus produces a precipitate, and the fluid above becomes clear and green, while water and the folution of mucus form a turbid dirty-coloured fluid.

5. Alkaline lixivium diffolves, though fometimes with difficulty, mucus, and generally pus.

6. Water precipitates pus from fuch a mixture, but does not mucus.

7. Where alkaline lixivium does not diffolve pus, it ftill diftinguifhes it from mucus, as it then prevents its diffufion through water.

8. Coagulable lymph is neither foluble in concentrated nor diluted vitriolic acid.

9. Water produces no change on a folution of ferum in alkaline lixivium, until after long ftanding, and then only a very flight fediment appears.

10. Corrofive fublimate coagulates mucus, but does not pus.

From the above experiments it appears, that ftrong vitriolic acid and water, diluted vitriolic acid, and cauftic alkaline lixivium and water, will ferve to diftinguifh pus from mucus; that the vitriolic acid can feparate it from coagulable lymph, and alkaline lixivium from ferum.

Hence, when a perfon has any expectorated matter, the compofition of which he wifhes to afcertain, let him diffolve it in vitriolic acid, and in cauftic alkaline

Mud.

line lixivium. And let him add pure water to both folutions. If there be a fair precipitation in each, he may be affured that fome pus is prefent. But if there be a precipitation in neither, it is a certain teft that the mixture is entirely mucus. If the matter cannot be made to diffolve in alkaline lixivium by time and trituration, we have alfo reafon to believe that it is pus.

MUD-INGUÁNA, the American name of a remarkable kind of two-footed amphibious animal found in South Carolina, firft obferved by Dr Garden of Charleftown, and afterwards defcribed by John Ellis, F.R.S. in the Phil. Tranf. p. 189.

" It is found (fays he) in fwampy and muddy places, by the fide of pools, under the trunks of old trees that hang over the water.

Plate CLXXXIV

" The leffer one B, which is preferved in fpirits, meafures about 9 inches in length; and appears to be a very young ftate of the animal, as we may obferve from the fin of the tail, and the opercula or coverings of the gills being not yet extended to their full fize. Thefe opercula, in their prefent ftate, confift each of three indented lobes, hiding the gills from view, and are placed juft above the two feet. Thefe feet appear like little arms and hands, each furnifhed with four fingers, and each finger with a claw.

" In the fpecimen A, which is 31 inches long, the head is fomething like an eel, but more compreffed; the eyes are fmall, and placed as thofe of the eel are. In this they are fcarce vifible. This fmallnefs of the eye beft fuits an animal that lives fo much in mud. The noftrils are very plainly to be diftinguifhed; thefe, with the gills, and remarkable length of the lungs, fhew it to be a true amphibious animal. The mouth is fmall in proportion to the length of the body; but its palate and infide of the lower jaw (fee fig. C.) are well provided with many rows of pointed teeth: with this provifion of nature, added to the fharp exterior bony edges of both the upper and under jaw, the animal feems capable of biting and grinding the hardeft kind of food. The fkin, which is black, and full of fmall fcales, refembles fhagreen. Thefe fcales are of different fizes and fhapes, according to their fituation; but all appear funk into its gelatinous furface: thofe along the back and belly are of an oblong oval form, and clofe fet together; in the other parts they are round, and more diftinct. Both the fides are mottled with fmall white fpots, and have two diftinct lines compofed of fmall white ftreaks continued along from the feet to the tail. The fin of the tail has no rays, and is no more than an adipofe membrane like that of the eel; this fin appears more diftinctly in the dry animal than in thofe that have been preferved in fpirits.

" The opercula, or coverings to the gills, in dry fpecimens, appear fhrivelled up; but yet we may plainly fee that they have been doubly pennated. Under thefe coverings are the openings to the gills, three on each fide, agreeable to the number of the opercula. In the plate, at fig. F. the fins are reprefented as they appear when juft taken out of the water and put into the fpirits of wine.

" The form of thefe pennated coverings approach very near to what I have fome time ago obferved in the *larva*, or aquatic ftate of our Englifh lacerta, known by the name of *eft* or *water-newt*, (fee fig. D and E), which ferve them for coverings to their gills, and for fins to fwim with during this ftate; and which they lofe, as well as the fins of their tails, when they change and become land-animals; as I have obferved by keeping them alive for fome time myfelf.

Mud, Muffle.

" Recollecting thefe obfervations on the changes of our lizard, and at the fame time the many remarkable changes in frogs, I began to fufpect whether this animal might not be the larva ftate of fome large kind of lizard; and therefore requefted the favour of Dr Solander to examine with me the lacertas in the Britifh Mufeum, that we might fee whether any of the young ones had only two feet; but after carefully going thro' many kinds, we could plainly difcover four feet perfectly formed, even in thofe that were but juft coming out of their eggs.

" During this ftate of uncertainty, I forwarded to Dr Linnæus of Upfal, at Dr Garden's requeft, his account of the largeft fpecimen, and at the fame time fent him one of the fmaller fpecimens preferved in fpirits; defiring his opinion, for my own as well as Dr Garden's fatisfaction.

" About the end of January laft I was favoured with an anfwer from the profeffor, dated Upfal, Dec. 27th 1765; wherein he fays,

" I received Dr Garden's very rare two-footed animal with gills and lungs. The animal is probably the larva of fome kind of lacerta, which I very much defire that he will particularly inquire into. If it does not undergo a change, it belongs to the order of nantes, which have both lungs and gills; and if fo, it muft be a new and very diftinct genus, and fhould moft properly have the name of *firen*. I cannot poffibly defcribe to you how much this two-footed animal has exercifed my thoughts; if it is a larva, he will no doubt find fome of them with four feet. It is not an eafy matter to reconcile it to the larva of the lizard tribe, its fingers being furnifhed with claws; all the larvas of lizards that I know are without them, (*digitis muticis*). Then, alfo the branchiæ, or gills, are not to be met with in the aquatic falamanders, which are probably the larvas of lizards. Further, the croaking noife or found it makes, does not agree with the larvas of thofe animals; nor does the fituation of the anus. So that there is no creature that ever I faw, that I long fo much to be convinced of the truth, as what this will certainly turn out to be.

" *P. S.* In a letter lately received from Dr Garden, he mentions one remarkable property of this animal, which is, that his fervant endeavouring to kill one of them by dafhing it againft the ftones, it broke into three or four pieces: he further fays, that he has had an opportunity of feeing many of them lately of a much larger fize, and that he never faw one with more than two feet; fo that he is fully convinced that it is quite a new genus of the animal-kingdom."

MUFFLE, in chemiftry, a veffel much ufed in fome metallurgic operations. In figure it reprefents an oblong arch or vault, the hinder part of which is clofed by a femicircular plane, and the lower part, or floor of which, is a rectangular plane. It is a little oven that is placed horizontally in affay and enamelling furnaces, fo that its open fide correfponds with the door of the fire-place of the furnace. Under this arched oven fmall cupels, or crucibles, are placed; and the fubftances contained are thus expofed to heat without con-

tact

tact of fuel, ſmoke, or aſhes.

MUFTI, the chief of the eccleſiaſtical order, or primate of the muſſulman religion. The authority of the mufti is very great in the Ottoman empire; for even the ſultan himſelf, if he would preſerve any appearance of religion, cannot, without hearing his opinion, put any perſon to death, or ſo much as inflict any corporal puniſhment. In all actions, eſpecially criminal ones, his opinion is required, by giving him a writing in which the caſe is ſtated under feigned names; which he ſubſcribes with the words, *He ſhall*, or, *Shall not be puniſhed.* Such outward honour is paid to the mufti, that the grand ſignior himſelf riſes up to him, and advances ſeven ſteps to meet him when he comes into his preſence. He alone has the honour of kiſſing the ſultan's left ſhoulder, whilſt the prime vizier kiſſes only the hem of his garment. When the grand ſignior addreſſes any writing to the mufti, he gives him the following titles: *To the eſad, the wiſeſt of the wiſe, inſtructed in all knowledge, the moſt excellent of excellents, abſtaining from things unlawful, the ſpring of virtue and of true ſcience, heir of the prophetic doctrines, reſolver of the problems of faith, revealer of the orthodox articles, key of the treaſures of truth, the light to the doubtful allegories, ſtrengthened with the grace of the ſupreme Legiſlator of mankind, may the Moſt High God perpetuate thy virtues!* The election of the mufti is ſolely in the grand ſignior, who preſents him with a veſt of rich ſables, &c. If he is convicted of treaſon, or any great crime, he is put into a mortar kept for that purpoſe in the Seven Towers at Conſtantinople, and pounded to death.

MUGGLETONIANS, a religious ſect which aroſe in England about the year 1657; ſo denominated from their leader Lodowick Muggleton, a journeyman-taylor, who, with his aſſociate Reeves, ſet up for great prophets, pretending, as it is ſaid, to have an abſolute power of ſaving and damning whom they pleaſed; and giving out that they were the two laſt witneſſes of God that ſhould appear before the end of the world.

MUGIL, the MULLET; in ichthyology, a genus of fiſhes belonging to the order of abdominales. The lips are membranaceous, the inferior one being carinated inwards; they have no teeth; the branchioſtege membrane has ſeven crooked rays; the opercula are ſmooth and round; and the body is of a whitiſh colour. There are two ſpecies, diſtinguiſhed by the number of rays in the back-fin.

The mullet is juſtly ranked by Ariſtotle among the *piſces littorales*, or thoſe that prefer the ſhores to the full ſea; they are found in great plenty on ſeveral of the ſandy coaſts of our iſland, and haunt in particular thoſe ſmall bays that have influxes of freſh water. They come in great ſhoals, and keep rooting like hogs in the ſand or mud, leaving their traces in form of large round holes. They are very cunning: and when ſurrounded with a net, the whole ſhoal frequently eſcapes by leaping over it; for when one takes the lead, the others are ſure to follow. This circumſtance is obſerved by Oppian; who alſo informs us, that if theſe fiſhes fail to get over at the firſt leap, they never attempt a ſecond, but lie without motion as if they reſigned themſelves to their fate. Mr Pennant ſays he is uncertain whether this laſt obſervation holds good or not: however, Oppian had good opportunity of examining thoſe fiſh, as they ſometimes ſwarm on the coaſts of the Mediterranean. Near Martegues, in the ſouth of France, abundance of mullets are taken in weres made of reeds placed in the ſhallows. Of the milts of the males, which are there called *alletants*, and of the roes of females, which are called *botar*, is made botargo. The materials are taken out entire, covered with ſalt for four or five hours, then preſſed a little between two boards or ſtones, waſhed, and at laſt dried in the ſun for 13 or 14 days.

This fiſh was ſometimes made the inſtrument of a horrible puniſhment for unfortunate gallants. It was uſed both at Athens and Rome; but it is very doubtful whether it was a legal puniſhment or not. By Horace it is mentioned in the following lines:

Diſcincta tunica fugiendum eſt, et pede nudo;
Ne nummi pereant, aut PYGA, *aut denique fama.*
Satyr. II. lib. i. 132.

The mullet is an excellent fiſh for the table, but at preſent not a faſhionable one.

MUGWORT, in botany, a ſpecies of ARTEMISIA. An infuſion of this plant in white wine, or a bath made of it, has been always eſteemed an emmenagogue, and uſeful in difficult parturition. The leaves, when young and tender, are frequently made uſe of by the Highlanders of Scotland as a pot-herb. The country-people in Sweden drink a decoction of them for the ague.

MUID, a large meaſure in uſe among the French, for things dry. The muid is no real veſſel uſed as a meaſure, but an eſtimation of ſeveral other meaſures; as the ſeptier, mine, minot, buſhel, &c.

MUID, is alſo one of the nine caſks, or regular veſſels uſed in France, to put wine and other liquors in. The muid of wine is divided into two demi-muids, four quarter muids, and eight half-quarter muids, containing 36 ſeptiers.

MULATTO, a name given in the Indies to thoſe who are begotten by a negro man on an Indian woman, or by an Indian man on a negro woman.

MULBERRY, in botany. See MORUS.

MULCT, a fine of money laid upon a man who has committed ſome fault or miſdemeanour.

MULE, in zoology, a mongrel kind of quadruped, uſually generated between an aſs and a mare, and ſometimes between a horſe and a ſhe-aſs; but the ſignification of the word is commonly extended to every kind of animal produced by a mixture of two different ſpecies. There are two kinds of theſe animals; one from the he-aſs and mare, the other from the horſe and the ſhe-aſs. We call them indifferently *mules*, but the Romans diſtinguiſhed them by proper appellations. The firſt kind are the beſt and moſt eſteemed; as being larger, ſtronger, and having leaſt of the aſs in their diſpoſition. The largeſt and ſtouteſt aſſes, and the faireſt and fineſt mares, are choſen in thoſe countries where theſe creatures are moſt in uſe; as in Spain, Italy, and Flanders. In the laſt eſpecially, they ſucceeded in having very ſtately mules from the ſize of their mares, ſome of them 16, and ſome 17 hands high, which are very ſerviceable as ſumpter-mules in the army. But, ſince the Low Countries are no longer under the dominion of Spain, they breed fewer mules. Theſe creatures are very much commended for their being ſtronger, ſurer footed, going eaſier, being more cheaply maintained,

tained, and lasting longer than horses. They are commonly of a black-brown, or quite black, with that shining list along the back and cross the shoulders, which distinguishes asses. In former times they were much more common in this country than at present; being often brought over in the days of Popery by the Italian prelates. They continued longest in the service of millers; and are yet in use among them in some places, on account of the great loads they carry on their back. As they are capable of being trained for riding, bearing burdens, and for draught, there is no doubt that they might be usefully employed in many different services. But they are commonly found to be vicious, stubborn, and obstinate to a proverb; which whether it occasions or is produced by the ill usage they meet with, is a point not easily settled. Whatever may be the case of asses, it is allowed that mules are larger, fairer, and more serviceable in mild than in warm climates. In the British American colonies, both on the continent and in the islands, but especially in the latter, they are much used and esteemed; so that they are frequently sent to them from hence, suffer less in the passage, and die much seldomer than horses, and commonly yield, when they arrive, no inconsiderable profit.

It hath commonly been asserted, that animals produced by the mixture of two heterogeneous species, are incapable of generating, and thus perpetuating the monstrous breed; but this, we are informed by M. Buffon, is now discovered to be a mistake. Aristotle, says he, tells us, that the mule engenders with the mare, and that the junction produces an animal which the Greeks call *hinnus*, or *ginnus*. He likewise remarks, that the she-mule easily conceives, but seldom brings the fœtus to perfection. But the most remarkable and well attested instance of this fact, is mentioned in a letter read by M. d'Alembert before the academy of sciences, which informed him that a she-mule in the island of St Domingo had brought forth a foal. The fact was attested by persons of the most unquestionable veracity; and other instances, though not so well authenticated, are adduced by our author. We may therefore, continues M. Buffon, consider it as an established fact, that the he-mule can generate, and the she-mule produce. Like other animals, they have a seminal liquor, and all the organs necessary to generation. But mongrel animals are always less fertile and more tardy than those of a pure species. Besides, mules have never produced in cold climates, seldom in warm regions, and still more seldom in temperate countries. Hence their barrenness, without being absolute, may be regarded as positive; since their productions are so rare, that a few examples can be only collected.

The translator of Buffon's works, in a note on the passage above-quoted, hath given a remarkable and well authenticated instance of the prolific powers of a she-mule in the north of Scotland. Having heard that a mule, belonging to Mr David Tullo farmer in Auchtertyre, in the county of Forfar, had some years ago brought forth a foal, he transmitted a few queries to be put to Mr Tullo; and requested that his answers might be legally attested before a magistrate. This request was cheerfully complied with; and the following is an exact copy of the queries, answers, and attestations.

Interrogatories to be put to Mr Tullo tenant in Auchtertyre, parish of Newtyle, and county of Forfar, with his answers thereto.

1mo, Had you ever a she-mule? At what period? Is it true that the mule had a foal? At what time was she covered; and when did she foal?

Answered by Mr Tullo: That he bought a she-mule about 20 years ago: That she was constantly in season for a horse: That, about some years thereafter, he gave her a horse; and that she thereafter gave him a foal, about the 10th of June. The mule's price was 4*l.* 5*s.* Sterling.

2do, What was the colour of the foal? Was there any thing particular in its figure?

Answer: The foal was exactly the colour of its mother, inclined to black, with a very large head, big ears, and small tail; and the declarant thinks, had its head been weighed when foaled, it would have weighed nearly as much as its body.

3tio, How long was the animal allowed to live?

Answer: The next day after the mule foaled, it was sent, with its mother, to the Loch of Lundie, in order to let the foal die, as the declarant could not want the mule's work, and the mother seemed not fond of the foal: That it was accordingly left, and next day came to Auchtertyre, about two miles distance, over a hill, with the cattle of Auchtertyre, that had been grazing near to that place, and was drowned in a ditch the day following.

4to, Was its skin preserved, or the head, or any other bones of the skeleton? Could any part thereof be still found?

Answered: Neither the skin, nor any part of the skeleton was preserved, nor can now be had; though the declarant has often regretted the not preserving the foal, as its mother always performed any work that a horse of 15*l.* value could do.

5to, Is the mother still alive? What is her age?

Answer: The mother died about eight years ago, of an epidemic cold that was raging among the horses in this country: The mule had little or no milk after foaling, and the foal got some cow's milk: And this is all that he remembers of the matter. David Tullo.

Auchtertyre, 4th February 1780.

We James Small tenant in Burmouth, and Robert Ramsay tenant in Newtyle, hereby certify, That we have often seen the mule above-described; and we know that she had a foal, as is narrated by David Tullo.

James Small. Rob. Ramsay.

Ballantyne house, 4th February 1780.

The within interrogatories were put to David Tullo tenant in Auchtertyre, anent he mule he had, and the foal she produced; to which he gave the answers subjoined to each query, and signed them; as did James Small and Robert Ramsay, attesting the truth thereof, in presence of George Watson, J. P.

The original attestation is in the possession of the translator; and he lately transmitted notorial or authenticated copies of it to the count de Buffon, and to Thomas Pennant, Esq; of Downing, in Flintshire.

MULIER, in law, signifies the lawful issue born in wedlock, though begotten before. The mulier is pre-

preferred to an elder brother born out of matrimony; as for inftance, if a man has a fon by a woman before marriage, which iffue is a baftard, and afterwards marries the mother of the baftard, and they have another fon, this fecond fon is mulier and lawful, and fhall be heir of the father; but the other can be heir to no perfon †. By the civil law, where a man has iffue by a woman, if after that he marries her, the iffue is mulier.

† See the article *Baftard.*

MULL, one of the Weftern Iflands of Scotland, about 24 Scots miles long, and as much in breadth. It is in general rocky and barren, not producing a fufficient quantity of corn for the inhabitants; but about 1800 head of cattle are annually exported. The ifland was originally part of the dominions of the Lords of the Ifles; but in after-times it became part of the poffeffions of the ancient and valiant family of Macleanes, who ftill retain one-half. The other is the litigated property of the duke of Argyle, whofe anceftor poffeffed himfelf of it in 1674, on account of a debt; but after the courts of law had made an adjudication in his favour, he was obliged to fupport their decree by force of arms.

Mull *of Cantire*, the fouth cape or promontory of the county of Cantire or Mull, in the frith of Clyde, in the weft of Scotland.

Mull *of Galloway*, the fouth cape or promontory of all Scotland, in the county of Galloway, on the Irifh Sea.

MULLER, or Regiomontanus (John), a celebrated aftronomer of the 15th century, was born at Koningfhoven in Franconia in 1436, and acquired great reputation by publifhing an abridgment of Ptolemy's Almageft, which had been begun by Purback. He went to Rome to perfect himfelf in the Greek tongue, and to fee the cardinal Baffarion; but finding fome faults in the Latin tranflations of George de Trebizond, that tranflator's fon affaffinated him in a fecond journey he made to Rome in 1476, where Pope Sixtus IV. had provided for him the archbifhopric of Ratifbon, and had fent for him to reform the calendar. Others fay that he died of the plague.

MULLERAS, a town of Germany, in the circle of Upper Saxony, and marquifate of Brandenburg, feated 38 miles fouth of Berlin, upon a canal which joins the Oder and the Spree. This canal is 15 miles in length, 10 yards in breadth, and feven feet in depth. It was eight years in making; and fince that time the cities of Hamburg and Breflaw have carried on great trade by water. E. Long. 14. 50. N. Lat. 52. 21.

MULLET, in ichthyology. See Mugil.

Mullet, or *Mollet*, in heraldry, a bearing in form of the rowel of a fpur, which it originally reprefented. See Plate CXLIV.

MULLUS, in ichthyology, a genus of fifhes belonging to the order of thoracici. The *barbatus*, or red furmullet, was highly efteemed by the Romans, and bore an exceeding high price. The capricious epicures of Horace's days valued it in proportion to its fize; not that the larger were more delicious, but that they were more difficult to be got. The price that was given for one in the time of Juvenal and Pliny, is a ftriking evidence of the luxury and extravagance of the age:

> Mullum *fex millibus emit*
> *Æquantem fane paribus feftertia libris* ‡. Juv. Sat. IV.
>
> The lavifh flave
> Six thoufand pieces for a mullet gave,
> A fefterce for each pound. Dryden.

‡ 48 *l.* 8 *s.* 9 *d.*

But Afinius Celer, a man of confular dignity, gave a ftill more unconfcionable fum; for he did not fcruple beftowing 8000 *nummi*, or 64l. 11s. 8d. for a fifh of fo fmall a fize as the mullet: for, according to Horace, a *mullus trilibris*, or one of 3 ℔. was a great rarity; fo that Juvenal's fpark muft have had a great bargain in comparifon of what Celer had.

But Seneca fays, that it was not worth a farthing except it died in the very hand of your gueft: that fuch was the luxury of the times, that there were ftews even in the eating-rooms, fo that the fifh could at once be brought from under the table, and placed on it: that they put the mullets in tranfparent vafes, that they might be entertained with the various changes of its rich colour while it lay expiring. Apicius, a wonderful genius for luxurious inventions, firft hit upon the method of fuffocating them in the exquifite Carthaginian pickle, and afterwards procured a rich fauce from their livers. This is the fame gentleman whom Pliny, in another place, honours with the title of *Nepotum omnium altiffimus gurges;* an expreffion too forcible to be rendered in our language.

Mr Pennant has heard of this fpecies being taken on the coaft of Scotland, but had no opportunity of examining it; and whether it is found in the weft of England with the other fpecies or variety, we are not at this time informed. Salvianus makes it a diftinct fpecies, and fays that it is of a purple colour, ftriped with golden lines, and that it did not commonly exceed a palm in length: no wonder then that fuch a prodigy as one of 6 ℔. fhould fo captivate the fancy of the Roman epicure.

Mr Ray eftablifhes fome other diftinctions, fuch as the firft dorfal fin having nine rays, and the colour of that fin, the tail, and the pectoral fins, being of a very pale purple.

MULTIPLE, in arithmetic, a number which comprehends fome other feveral times: thus 6 is a multiple of 2, and 12 is a multiple of 6, 4, and 3; comprehending the firft twice, the fecond thrice, &c.

Action *of* MULTIPLEPOINDING, in Scots law. See Law, n° clxxxiii. 24.

MULTIPLICAND, in arithmetic, the number to be multiplied by another. See there, n° 10.

MULTIPLICATION, in general, the act of increafing the number of any thing.

Multiplication, in arithmetic, is a rule by which any given number may be fpeedily increafed, according to any propofed number of times *.

* See *Arithmetic*, n° 10.

Multiplication, in algebra. See Algebra, n° 5.

MULTIPLICATOR, or Multiplier, in arithmetic, the number by which any other is multiplied, or the number of times it is fuppofed to be taken. See Arithmetic, n° 10.

MULTIPLICATUS flos, a luxuriant flower, whofe petals are multiplied fo as to exclude a part of the ftamina.

A multiplied luxuriant flower differs from a full one, the higheſt degree of luxuriance, in that the petals of the latter are ſo multiplied as to exclude all the ſtamina: whereas thoſe of the former are only repeated or multiplied, two, three, or four times, as to the excluſion of only a ſmall part of the eſſential organs.

MULTIPLYING-GLASS, in optics, a glaſs wherewith objects appear increaſed in number. See (the *Index* ſubjoined to) OPTICS.

MULTURE, in Scots law, the quantity of grain paid to the proprietor or tackſman of a mill, for grinding.

MULVIA, a river of Barbary in Africa, which riſes in the mountains of Atlas, and divides the empire of Morocco from that of Algiers, and then falls into the Mediterranean, to the weſtward of Marſalquiver.

MUM, a kind of malt-liquor much drank in Germany, and chiefly brought from Brunſwick, which is the place of moſt note for making it. The proceſs of brewing mum, as recorded in the town-houſe of that city, is as follows: Take 63 gallons of water that has been boiled till one-third part is conſumed, and brew it with ſeven buſhels of wheaten malt, one buſhel of oat-meal, and one buſhel of ground beans. When it is tunned, the hogſhead muſt not be filled too full at firſt: as ſoon as it begins to work, put into it three pounds of the inner rind of fir, one pound of the tops of fir and beach, three handfuls of carduus benedictus, a handful or two of the flower of roſa ſolis: add burnet, betony, marjoram, avens, pennyroyal, and wild thyme, of each an handful and an half; of elder-flowers, two handfuls or more; ſeeds of cardamom bruiſed, 30 ounces; barberries bruiſed, one ounce: when the liquor has worked a while, put the herbs and ſeeds into the veſſel; and, after they are added, let it work over as little as poſſible; then fill it up: laſtly, when it is ſtopped, put into the hogſhead ten new-laid eggs unbroken; ſtop it up cloſe, and uſe it at two years end. The brewers of this country, inſtead of the inner rind of fir, uſe cardomom, ginger, and ſaſafras; and alſo add elicampane, madder, and red ſanders. Mum, on being imported, pays for every barrel 1 l. 5 s.

MUMMY, a body embalmed or dried, in the manner uſed by the ancient Egyptians; or the compoſition with which it is embalmed. There are two kinds of bodies denominated *mummies*. The firſt are only carcaſes dried by the heat of the ſun, and by that means kept from putrefaction: theſe are frequently found in the ſands of Libya. Some imagine, that theſe are the bodies of deceaſed people buried there on purpoſe to keep them entire without embalming; others think they are the carcaſes of travellers, who have been overwhelmed by the clouds of ſand raiſed by the hurricanes frequent in thoſe deſarts. The ſecond kind of mummies are bodies taken out of the catacombs near Cairo, in which the Egyptians depoſited their dead after embalming. See EMBALMING.

We have two different ſubſtances preſerved for medicinal uſe under the name of *mummy*, though both in ſome degree of the ſame origin. The one is the dried and preſerved fleſh of human bodies, embalmed with myrrh and ſpices; the other is the liquor running from ſuch mummies, when newly prepared, or when affected by great heat or damps. The latter is ſometimes in a liquid, ſometimes of a ſolid form, as it is preſerved in vials well ſtopped, or ſuffered to dry and harden in the air. The firſt kind of mummy is brought to us in large pieces, of a lax and friable texture, light and ſpungy, of a blackiſh brown colour, and often damp and clammy on the ſurface: it is of a ſtrong but diſagreeable ſmell. The ſecond kind of mummy, in its liquid ſtate, is a thick, opaque, and viſcous fluid, of a blackiſh colour, but not diſagreeable ſmell. In its indurated ſtate, it is a dry ſolid ſubſtance, of a fine ſhining black colour, and cloſe texture, eaſily broken, and of a good ſmell; very inflammable, and yielding a ſcent of myrrh and aromatic ingredients while burning. This, if we cannot be content without medicines from our own bodies, ought to be the mummy uſed in the ſhops; but it is very ſcarce and dear; while the other is ſo cheap, that it will always be moſt in uſe.

All theſe kinds of mummies are brought from Egypt. But we are not to imagine, that any body breaks up the real Egyptian mummies, to ſell them in pieces to the druggiſts, as they make a much better market of them in Europe whole, when they can contrive to get them. What our druggiſts are ſupplied with, is the fleſh of executed criminals, or of any other bodies the Jews can get, who fill them with the common bitumen, ſo plentiful in that part of the world; and adding a little aloes, and two or three other cheap ingredients, ſend them to be baked in an oven, till the juices are exhaled, and the embalming matter has penetrated ſo thoroughly that the fleſh will keep and bear tranſporting into Europe. Mummy has been eſteemed reſolvent and balſamic: but whatever virtues have been attributed to it, ſeem to be ſuch as depend more upon the ingredients uſed in preparing the fleſh, than in the fleſh itſelf; and it would ſurely be better to give thoſe ingredients without ſo ſhocking an addition.

MUMMY, among gardeners, a kind of wax uſed in grafting and planting the roots of trees, made in the following manner: Take one pound of black pitch, and a quarter of pound of turpentine; put them together into an earthen pot, and ſet them on fire in the open air, holding ſomething in your hand to cover and quench the mixture in time, which is to be alternately lighted and quenched till all the nitrous and volatile parts be evaporated. To this a little common wax is to be added; and the compoſition is then to be ſet by for uſe.

MUMPS. See MEDICINE, n° 526.

MUNDA, an ancient town of Spain, in the kingdom of Granada, ſeated on the declivity of a hill, at the bottom of which runs a river. W. Long. 4. 13. N. Lat. 48. 15.

MUNICH, a town of Germany, capital of the whole duchy of Bavaria, and the reſidence of the elector. It ſtands on the Iſer, 70 miles ſouth of Ratiſbon, and 214 weſt of Vienna, being one of the moſt pleaſant and populous cities of Germany for its bigneſs. The number of the inhabitants is ſaid to be about 40,000. Having been built at firſt on a ſpot of ground belonging to a convent, it had from thence, in German, the name of *Munchen*, i. e. *Monk's-town*, and a monk for its arms. The elector's palace here is a very grand ſtructure, conſiſting of ſeveral courts, fur-

furniſhed and adorned in the moſt magnificent manner, with tapeſtry, gilding, ſculpture, ſtatues, and paintings. It contains an amazing collection of jewels, antiquities, and curioſities. The great hall is 118 feet long, and 52 broad; and the ſtair-caſe leading to it, from top to bottom, of marble and gold. In the hall of antiquities are 354 buſts and ſtatues of jaſper and porphyry, braſs and marble. In this palace alſo is a library, containing a vaſt collection of books, and many valuable manuſcripts, in moſt languages, ancient and modern; and a chamber of rarities, among which is the picture of a bravo, or aſſaſſin, who is ſaid to have committed 345 murders with his own hand, and to have been accomplice in, or privy to, 400 more. The treaſury in the chapel contains alſo a vaſt number of pictures, precious ſtones, medals, veſſels of gold and ſilver, &c. Among other curioſities, here is a cherry-ſtone with 140 heads diſtinctly engraved upon it. The gardens of the palace are alſo very fine, and it is ſaid a ſecret paſſage leads from it to all the churches and convents in the town. There is a great number of other fine buildings in this city, public and private, particularly the riding-houſe, town-houſe, opera-room, the Jeſuits college, the large edifice for tournaments, the churches, convents, fountains, &c. Its manufactures are thoſe of ſilk, particularly velvet, woollen cloths, and tapeſtry; and it has two annual fairs, at which great quantities of ſalt, wine, &c. are ſold. The ſtreets are broad and regular; and moſt of the houſes well built, and painted on the outſide. The market-place is extremely beautiful. Mr Keyſler ſays, the ſervant-maids at the great inns here, on holidays, wear a ſilver chain round their necks, conſiſting of three rows; and that their breaſts are likewiſe laced with two other chains of the ſame metal. He further obſerved, that it was a general cuſtom to place a green garland, on a bundle of ſtraw, before every houſe containing the corpſe of an unmarried perſon. The common ſalutation here, and in the other catholic countries of Germany, is, *Praiſed be Jeſus Chriſt;* and the anſwer returned, *For ever amen:* two popes having granted an indulgence of 100 days each time to all that uſe it. Not far from Munich are four other palaces, with fine gardens, belonging to the elector, viz. thoſe of Sleiſheim, Nymphenburg, Dauchau, and Starenberg. The firſt and laſt are about three leagues from the capital; the ſecond about half a league; and the third about two, at a market-town of the ſame name.

MUNICIPAL, in the Roman civil law, an epithet which ſignifies inveſted with the rights and privileges of Roman citizens. Thus the municipal cities were thoſe whoſe inhabitants were capable of enjoying civil offices in the city of Rome: theſe cities, however, according to Mariana, had fewer privileges than the colonies; they had no ſuffrages or votes at Rome, but were left to be governed by their own laws and magiſtrates. Some few municipal cities, however, obtained the liberty of votes.

MUNICIPAL, among us, is applied to the laws that obtain in any particular city or province. And thoſe are called *municipal officers* who are elected to defend the intereſt of cities, to maintain their rights and privileges, and to preſerve order and harmony among the citizens; ſuch as mayors, ſheriffs, conſuls, &c.

MUNITION, the proviſions with which a place is furniſhed, in order for defence; or that which follows a camp for its ſubſiſtence.

MUNITION *Ships*, are thoſe that have ſtores on board in order to ſupply a fleet of men of war at ſea. In an engagement, all the munition-ſhips and victuallers attending the fleet take their ſtation in the rear of all the reſt; they are not to engage in the fight, but to attend ſuch directions as are ſent them by the admiral.

MUNSTER (Sebaſtian), a learned writer, was born at Ingelheim, and became a cordelier; but having embraced Luther's ſentiments, he quitted that order in 1529, and retired to Heidelberg, and afterwards to Baſil, where he taught with reputation. He was a man of great candour, and void of ambition; and was ſo well ſkilled in geography, the mathematics, and the Hebrew tongue, that he was ſurnamed the *Eſdras* and the *Strabo of Germany*. His Latin tranſlation of the bible is eſteemed. He was the firſt who wrote a Chaldee grammar and lexicon: he alſo publiſhed a treatiſe on coſmography, and ſeveral other works. He died of the plague at Baſil in 1552, aged 63.

MUNSTER, in Latin *Monomia*, and in Iriſh *Moun*, the moſt ſoutherly province of Ireland; bounded on the ſouth by the Vergivian ſea, on the weſt by the Atlantic ocean, on the north by the river Shannon which parts it from Connaught, and on the eaſt by the Iriſh ſea. Its length is about 130 miles; but its breadth is very unequal, being from 68 miles to 120. The air is healthful and temperate; and the ſoil, where properly cultivated, is fruitful both in corn and graſs; but the mountains are bleak and barren. The northern parts, being the moſt level and fertile, are the beſt improved and incloſed. Vaſt numbers of cattle are fed in the province; which is alſo well ſupplied with fiſh, eſpecially cod and herrings.

MUNSTER, a territory of Germany, in the circle of Weſtphalia; bounded on the north by Embden and Oldenburg, on the ſouth by the county of Mark and duchy of Weſtphalia, on the weſt by the county of Bentheim and the United Provinces, and on the eaſt by the biſhoprics of Oſnaburg and Paderborn together with the county of Ravenſberg. It is the largeſt of all the Weſtphalian biſhoprics, being in length about 80 miles, and in breadth from 20 to 60. It is divided into 13 bailiwics; and tho' in general but a barren country, has ſome fruitful plains, with woods, and quarries of ſtone. The inhabitants, excepting a few of the nobility and gentry, are all Roman Catholics; though Lutheraniſm had once a conſiderable footing here. The biſhop, who is generally alſo elector of Cologne, has a revenue from hence of about 70,000 pounds, and can maintain 8000 men. In conſequence of an unjuſt cuſtom, unknown in the reſt of the empire, he is heir to all ſtrangers who die in the country without children. In the matricula he is rated at 30 foot, and 118 horſe; or 832 florins monthly in lieu of them. His chapter conſiſts of 40 canons, who are all noble.

MUNSTER, a city of Germany, capital of a biſhopric of the ſame name and of all Weſtphalia, ſtands at the conflux of the river Aa with the Ems, in E. Long. 7. 49. N. Lat. 52. 0. It is of a circular form,

form, large, and well fortified both by nature and art. It hath a fine citadel called the *Brille*, erected by a bishop named *Bernard van Galen* in order to awe the burghers. The dean and chapter now elect the bishop; but till the beginning of the 13th century he was nominated by the emperor. This city has been rendered famous by three remarkable transactions 1. By the peace concluded here in 1648, which put an end to a war of 30 years; occasioned by the persecuting spirit of bigotted papists, who chose rather to plunge their country into all the calamities of war than allow liberty of conscience to the Protestants. By this peace, however, they consented, much against their inclinations, to grant them a toleration. 2. By the disorders and disturbances occasioned here in 1553, by a parcel of enthusiasts called the *Munster Anabaptists*, who, headed by a taylor, called *John of Leyden*, from the place of his birth, turned out the magistrates, and took possession of the city, where they perpetrated the most horrid villanies and cruelties. 3. For the noble, though unsuccessful, efforts it made in defence of its liberties against the tyranny and usurpation of the above-mentioned turbulent and bloody-minded bishop, Bernard van Galen. In this city are a great number of convents, and other religious houses, many of them stately piles, and surrounded with beautiful gardens.

MUNYCHIA, or *Munychius Portus*, (anc. geogr.) a village and port of Athens, nearer to the city, less than and fortified in the same manner with the Piræeus, to the east of which it lay, or between it and the promontory Sunium, at the mouth of the Ilissus. Strabo says it was an eminence in form of a peninsula, at the foot of which stood three harbours, anciently encompassed with a wall, taking within its extent the Piræeus and other harbours, full of docks, with the temple of Diana Munychia, (Pausanias); taking its name from Mynichus, the founder of the temple, (Strabo, Plutarch).

MURÆNA, or Eel, in ichthyology; a genus of fishes, belonging to the order of apodes. The head is smooth; there are ten rays in the membrane of the gills; the eyes are covered with a common skin; and the body is cylindrical and slimy. There are seven species, distinguished by their fins, tail, &c. The most remarkable are,

1. The *anguilla*, or common eel, is very frequent in all our fresh waters, ponds, ditches, and rivers: according to Mr Pennant, it is the most universal of fish, yet is scarce ever found in the Danube, though very common in the lakes and rivers of Upper Austria.

The eel is very singular in many things relating to its natural history, and in some respects borders on the nature of the reptile tribe. It is known to quit its element, and during night to wander along the meadows, not only in order to change its habitation, but also for the sake of prey, feeding on snails as it passes along. During winter it beds itself deep in the mud, and continues in a state like the serpent-kind. It is very impatient of cold, and will eagerly take shelter in a wisp of straw flung into a pond in severe weather, which has sometimes been practised as a method of taking them. Albertus affirms, that he has known eels to take shelter in a hay-rick; yet all perished through excess of cold.

It has been observed in a river of England called the *Nyne*, there is a variety of small eel, with a lesser head and narrower mouth than the common kind, that is found in clusters in the bottom of the river, and is called the *bed-eel*: these are sometimes roused up by the violent floods, and are never found at that time with meat in their stomach.

There is scarce any animal the generation of which has puzzled the learned more than this. Aristotle first broached an opinion that eels were of no sex, nor did propagate their species like other animals, but were equivocally gendered of the mud; and as wild and absurd a system as this is, there have not been wanting many, even in these latter and more enlightened times, who have given into it. But there is now no room to doubt that all animals are produced by the copulation of parents like themselves; and the finding of eels in new ponds is easily accounted for from the above-mentioned circumstance of their migration. Dr Plot, and many others, have given accounts of whole droves of them leaving one ditch or pond to go to another.

Though the learned world at this time generally allows that eels are produced like other animals, by parents of their own kind, yet there remain many doubts about the manner in which the generation is performed. Some allow the eels to be, like the generality of other animals, of different sexes in the different individuals; and others affirming that they are all hermaphrodites, each having the parts of generation of both sexes. Rondeletius affirms that they are of both sexes; and Mr Allan, who has given a very curious paper concerning them in the Philosophical Transactions, is of the same opinion; and both say, that the parts of the sexes may be discovered on a careful inspection; and some are found to be males, and others females; but these parts are, in both sexes, they say, buried in a large quantity of fat; and they are of opinion, that hence proceeded the mistake of Aristotle and his followers, who, not being able to find those parts, concluded that they did not exist at all. Among those who allow the eel to be produced, like other animals, from animal-parents which have the sexes, some are of opinion that they are viviparous, and others that they are oviparous: but Mr Chartwynd seems to have determined this controversy by observing, that if the aperture under the belly of the eel, which looks red in the month of May, be cut open at that time, the young eels will be seen to come forth alive after the operation. Mr Lewenhoeck says, that he found an uterus in every eel he examined; and therefore concludes, that they are hermaphrodites: and he supposes that they have no male parts of generation like those of other animals; but that the office of these is performed by a liquor analogous to the male seed of animals, which is contained in certain glands, situated on the inside of the uterus itself.

Eels have sometimes been met with in recent ponds, made at such a distance from any other water that we cannot reasonably suppose them to have migrated thither over land. But in these cases there is reason to believe, that the ponds have been supplied with them by the aquatic fowl of prey, in the same manner as vegetation is spread by many of the land-birds, either

either by being dropped, as they carry them to feed their young, or by paffing quick through their bodies, as is the cafe with herons.

Thefe fifh are extremely voracious, and deftructive to the fry of others. No fifh lives fo long out of water as the eel; and it is extremely tenacious of life, infomuch that its parts will move a confiderable time after they are flayed and cut in pieces. They vary much in their colours, from a footy hue to a light olive green; and thofe which are called *filver eels* have their bellies white, and a remarkable clearnefs throughout.

Befides thefe, there is a variety of this fifh known in the river Thames by the name of *grigs*, and about Oxford by that of *grigs* or *gluts*. Thefe are fcarce ever feen near Oxford in the winter; but appear in fpring, and bite readily at the hook, which common eels in that neighbourhood will not. They have a larger head, a blunter nofe, thicker fkin, and lefs fat, than the common fort; neither are they fo much efteemed, nor do they often exceed three or four pounds in weight.—Common eels grow to a large fize, fometimes weighing 15 or 20 pounds; but that is extremely rare. Mr Dale indeed, in the Philofophical Tranfactions, and fome others, bring inftances of eels much exceeding that fize; but Mr Pennant fufpects them to have been congers, fince the enormous fifh they defcribe have all been taken at the mouths of the Thames or Medway. The Romans held eels very cheap, probably on account of their likenefs to fnakes. On the contrary, the luxurious Sybarites were fo fond of thefe fifh, as to exempt from tribute of every kind thofe perfons who fold them.

2. The *conger*, or conger-eel, grows to a vaft fize. Dr Borlafe informs us, that they are fometimes taken near Mount's-bay of 100 lb. weight; and Mr Pennant affures us, that he has heard of fome taken near Scarborough that were 10 feet and a half long, and 18 inches in circumference in the thickeft part.

They differ from the common eel in the following particulars: 1. Their colour in general is more dark. 2. Their eyes much larger in proportion. 3. The irides of a bright filvery colour. 4. The lower jaw is rather fhorter than the upper. 5. The fide-line is broad, whitifh, and marked with a row of fmall fpots. 6. The edges of the dorfal and anal fins are black. 7. They have more bones than the common eel, efpecially along the back quite to the head. 8. They grow to a much larger fize.

As to the diftinction that Mr Ray and other writers make of the fmall beards at the end of the nofe, Mr Pennant thinks it not to be depended on, being fometimes found in both kinds, and fometimes entirely wanting.

Probably they generate like the frefh-water fpecies. Innumerable quantities of what are fuppofed to be their fry, come up the Severn about the month of April, preceding the fhads, which it is conjectured migrate into that river to feed on them: they are called *elvers*. They fwarm during their feafon, and are taken in a kind of fieve made of hair-cloth, fixed to a long pole; the fifherman ftanding on the edge of the water during the tide, puts in his net as far as he can reach, and drawing it out again, takes multitudes at every fweep, and will take as many during one tide as will fill a bufhel. They are dreffed, and reckoned very delicate.

Congers are extremely voracious, preying on other fifh, and on crabs at the time they have loft their fhell and are in a foft ftate. They and eels in general are alfo particularly fond of carcafes of any kind, being frequently found lodged in fuch as are accidentally taken up.

Thefe fifh are an article of commerce in Cornwall; numbers are taken on that coaft, and exported to Spain and Portugal, particularly to Barcelona.

Some are taken by a fingle hook and line, but (becaufe that way is tedious, and does not anfwer the expence of time and labour) they are chiefly caught by *bulters*, which are ftrong lines 500 feet long, with 60 hooks, each eight feet afunder, baited with pilchards or mackarel; the bulters are funk to the ground by a ftone faftened to them: fometimes fuch a number of thefe are tied together as to reach a mile.

The fifhermen are very fearful of a large conger, left it fhould endanger their legs by clinging round them; they therefore kill them as foon as poffible by ftriking them on the navel.

They are afterwards cured in this manner: They are flit, and hung on a frame till they dry, having a confiderable quantity of fat, which it is neceffary fhould exude before they are fit for ufe. It is remarkable that a conger of 100 weight will wafte by drying to 24 lb.; the people therefore prefer the fmalleft, poffibly becaufe they are fooneft cured. During the procefs there is a confiderable ftench; and it is faid, that in the fifhing villages the poultry are fed with the maggots that drop from the fifh. a

The Portuguefe and Spaniards ufe thofe dried congers after they have been ground into a powder, to thicken and give a relifh to their foups. They are fold for about 40 fhillings the quintal, which weighs 126 lb.

A fifhery of congers, fays Mr Pennant, would be of great advantage to the inhabitants of the Hebrides. Perhaps they would at firft undertake it with repugnancy, from their abfurd averfion to the eel kind.

MURAL CROWN. See CROWN.

MURATORI (Lewis Anthony), a learned and celebrated Italian writer, born at Vignoles, in the territory of Bologna, in 1672. He early difcovered an extreme fondnefs for the learned languages and fciences; and this was feconded by an excellent education. After having completed his firft ftudies, he embraced the ftate of an ecclefiaftic; and applied himfelf to polite literature, philofophy, theology, civil law, antiquities, and other fciences; by which means he became in a manner univerfally learned. He was fcarce 22 years of age when he was made librarian of the Ambrofian library at Milan. In 1700 the duke of Modena, his fovereign, recalled him, and made him his librarian, and keeper of the archives of his duchy. Muratori difcharged this double employment during the reft of his life, and had no other benefice than the provoftfhip of Santa Maria del Pompófa. He acquired the efteem of the learned throughout Europe, who had recourfe to him for the lights they wanted. He became an affociate to the Academies of the Ar-

cades

Murcia, Murder.

cades of Rome, Della Crusca, and Colomberia of Florence, the Academy of Etrusca at Cortona, the Royal Society of London, and of the Imperial Academy of Olmutz; and died in 1750. He wrote a great number of learned works; the principal of which are, 1. *Anecdota*, or a collection of pieces taken from the Ambrosian library, 2 vols 4to. with learned notes and dissertations. 2. A treatise on the perfection of the Italian poetry, 2 vols, 4to. 3. *Anecdota Græca*, 3 vols 4to. 4. A genealogical history of the house of Modena, 2 vols, folio. 5. An excellent collection of the writers of the Italian history, 27 vols folio, with learned notes. 6. Another collection, under the title of *Antiquitates Italicæ*. 7. A collection of ancient inscriptions, under the title of *Novus Thesaurus*, 6 vols folio. 8. The annals of Italy, 12 vols 4to. in Italian, &c. 9. Letters, dissertations, Italian poems, &c.

MURCIA, the Pagan goddess of idleness.—The name is taken from *murcus* or *murcidus*, an obsolete word, signifying a dull, slothful, or lazy person.—The statues of this goddess were always covered with dust and moss, to express her idleness and negligence. She had a temple in Rome, at the foot of Mount Aventine.

MURCIA, a kingdom in Spain, bounded on the north by New Castile, on the east by the kingdom of Valencia, on the west by Andalusia and Granada, and on the south by the Mediterranean Sea. It is about 62 miles in length, and 58 in breadth; and its principal river is Segura. The soil is dry, because it seldom rains, and therefore it produces little corn or wine; but there is plenty of oranges, citrons, lemons, olives, almonds, mulberries, rice, pulse, and sugar. It has also a great deal of silk. It was taken from the Moors in 1265. The air is very healthful.

MURCIA, a large, handsome, and populous town of Spain, capital of a kingdom of the same name, with a bishop's see. It contains six parishes and a superb cathedral, the stairs of whose steeple are so contrived, that a man may ride up to the top, either on horseback or in a coach. It is situated in a pleasant plain, which abounds in fine gardens about the city, in which are the best fruits in Spain. It is seated on the river Segura, in W. Long. 0. 36. N. Lat. 37. 48.

MURDER, or MURTHER, in law, is thus defined, or rather described, by Sir Edward Coke: "when a person, of sound memory and discretion, unlawfully killeth any reasonable creature in being, and under the king's peace, with malice aforethought, either express or implied." The best way of examining the nature of this crime will be by considering the several branches of this definition.

1. It must be committed by a person *of sound memory and discretion:* for lunatics or infants are incapable of committing any crime; unless in such cases where they shew a consciousness of doing wrong, and of course a discretion, or discernment between good and evil.

2. Next, it happens when a person of such sound discretion *unlawfully killeth*. The unlawfulness arises from the killing without warrant or excuse: and there must also be an actual killing to constitute murder; for a bare assault, with intent to kill, is only a great misdemesnor, tho' formerly it was held to be murder.

Murder.

The killing may be by poisoning, striking, starving, drowning, and a thousand other forms of death, by which human nature may be overcome. Of these the most detestable of all is poison; because it can of all others be the least prevented, either by manhood or forethought. And therefore, by the stat. 22 Hen. VIII. c. 9. it was made treason, and a more grievous and lingering kind of death was inflicted on it than the common law allowed; namely, *boiling to death:* but this act did not live long, being repealed by 1 Edw. VI. c. 12. There was also, by the ancient common law, one species of killing held to be murder, which may be dubious at this day, as there hath not been an instance wherein it has been held to be murder for many ages past, viz. bearing false witness against another, *Black's Comment.* with an express premeditated design to take away his life, so as the innocent person be condemned and executed. The Gothic laws punished in this case both the judge, the witnesses, and the prosecutor; and, among the Romans, the *lex Cornelia de sicariis*, punished the false witness with death, as being guilty of a species of assassination. And there is no doubt but this is equally murder *in foro conscientiæ* as killing with a sword; though the modern law (to avoid the danger of deterring witnesses from giving evidence upon capital prosecutions, if it must be at the peril of their own lives) has not yet punished it as such. If a man, however, does such an act, of which the probable consequence may be, and eventually is, death; such killing may be murder, although no stroke be struck by himself, and no killing may be primarily intended: as was the case of the unnatural son who exposed his sick father to the air against his will, by reason whereof he died; and of the harlot, who laid her child under leaves in an orchard, where a kite struck it, and killed it. So too, if a man hath a beast that is used to do mischief; and he, knowing it, *suffers* it to go abroad, and it kills a man; even this is manslaughter in the owner: but if he had purposely *turned it loose*, though barely to frighten people, and make what is called *sport*, it is with us (as in the Jewish law) as much murder as if he had incited a bear or a dog to worry them. If a physician or surgeon gives his patient a potion or plaster to cure him, which, contrary to expectation, kills him, this is neither murder nor manslaughter, but mi[s]adventure; and he shall not be punished criminally, however liable he might formerly have been to a civil action for neglect or ignorance: but it hath been holden, that if it be not a *regular* physician or surgeon who administers the medicine, or performs the operation, it is manslaughter at the least. Yet Sir Matthew Hale very justly questions the law of this determination; since physic and salves were in use before licensed physicians and surgeons: wherefore he treats this doctrine as apocryphal, and fitted only to gratify and flatter licentiates and doctors in physic; though it may be of use to make people cautious and wary how they meddle too much in so dangerous an employment. In order also to make the killing murder, it is requisite that the party die within a year and a day after the stroke received, or cause of death administered; in the computation of which the whole day upon which the hurt was done shall be reckoned the first.

3. Farther: The person killed must be "*a reasonable*

 able creature in being, and under the king's peace," at the time of the killing. Therefore to kill an alien, a Jew, or an outlaw, who are all under the king's peace or protection, is as much murder as to kill the moft regular-born Englifhman; except he be an alien-enemy, in time of war. To kill a child in its mother's womb, is now no murder, but a great mifprifion: but if the child be born alive, and dieth by reafon of the potion or bruifes it received in the womb, it feems, by the better opinion, to be murder in fuch as adminiftered or gave them. As to the murder of baftard-children, fee Bastard.

4. Laftly, the killing muft be committed "*with malice aforethought,*" to make it the crime of murder. This is the grand criterion which now diftinguifhes murder from other killing: and this malice prepenfe, *malitia præcogitata*, is is not fo properly fpite or malevolence to the deceafed in particular, as any evil defign in general; the dictate of a wicked, depraved, and malignant heart; *un difpofition à faire un male chofe:* and it may be either *exprefs*, or *implied*, in law. Exprefs malice is when one, with a fedate deliberate mind and formed defign, doth kill another: which formed defign is evidenced by external circumftances difcovering that inward intention; as lying in wait, antecedent menaces, former grudges, and concerted fchemes to do him fome bodily harm. This takes in the cafe of deliberate duelling, where both parties meet avowedly with an intent to murder: thinking it their duty, as gentlemen, and claiming it as their right, to wanton with their own lives and thofe of their fellow-creatures; without any warrant or authority from any power either divine or human, but in direct contradiction to the laws both of God and man: and therefore the law has juftly fixed the crime and punifhment of murder on them, and on their feconds alfo. Yet it requires fuch a degree of paffive valour to combat the dread of even undeferved contempt, arifing from the falfe notions of honour too generally received in Europe, that the ftrongeft prohibitions and penalties of the law will never be entirely effectual to eradicate this unhappy cuftom, till a method be found out of compelling the original aggreffor to make fome other fatisfaction to the affronted party, which the world fhall efteem equally reputable as that which is now given at the hazard of the life and fortune, as well of the perfon infulted, as of him who hath given the infult. Alfo, if even upon a fudden provocation one beats another in a cruel and unufual manner, fo that he dies, tho' he did not intend his death, yet he is guilty of murder by exprefs malice; *i. e.* by an exprefs evil defign, the genuine fenfe of *malitia*. As when a park-keeper tied a boy that was ftealing wood to a horfe's tail, and dragged him along the park; when a mafter corrected his fervant with an iron bar, and a fchoolmafter ftamped on his fcholar's belly, fo that each of the fufferers died; thefe were juftly held to be murders, becaufe the correction being exceffive, and fuch as could not proceed but from a bad heart, it was equivalent to a deliberate act of flaughter. Neither fhall he be guilty of a lefs crime who kills another in confequence of fuch a wilful act as fhews him to be an enemy to all mankind in general; as going deliberately, and with an intent to do mifchief, upon a horfe ufed to ftrike, or coolly difcharging a gun among a multitude of people. So if a man refolves to kill the next man he meets, and does kill him, it is murder, although he knew him not; for this is univerfal malice. And if two or more come together to do an unlawful act againft the king's peace, of which the probable confequence might be bloodfhed; as to beat a man, to commit a riot, or to rob a park, and one of them kills a man; it is murder in them all, becaufe of the unlawful act, the *malitia præcogitata*, or evil intended beforehand.

Alfo in many cafes where no malice is expreffed, the law will imply it: as, where a man wilfully poifons another, in fuch a deliberate act the law prefumes malice, though no particular enmity can be proved. And if a man kills another fuddenly, without any, or without a confiderable provocation, the law implies malice; for no perfon, unlefs of an abandoned heart, would be guilty of fuch an act upon a flight or no apparent caufe. No affront, by words, or geftures only, is a fufficient provocation, fo as to excufe or extenuate fuch acts of violence as manifeftly endanger the life of another. But if the perfon fo provoked had unfortunately killed the other, by beating him in fuch a manner as fhewed only an intent to chaftife and not to kill him, the law fo far confiders the provocation of contumelious behaviour, as to adjudge it only manflaughter, and not murder. In like manner, if one kills an officer of juftice, either civil or criminal, in the execution of his duty, or any of his affiftants endeavouring to conferve the peace, or any private perfon endeavouring to fupprefs an affray or apprehend a felon, knowing his authority or the intention with which he interpofes, the law will imply malice, and the killer fhall be guilty of murder. And if one intends to do another felony, and undefignedly kills a man, this is alfo murder. Thus if one fhoots at A and miffes him, but kills B, this is murder; becaufe of the previous felonious intent, which the law transfers from one to the other. The fame is the cafe, where one lays poifon for A; and B, againft whom the prifoner had no malicious intent, takes it, and it kills him; this is likewife murder. So alfo, if one gives a woman with child a medicine to procure abortion, and it operates fo violently as to kill the woman, this is murder in the perfon who gave it. It were endlefs to go through all the cafes of homicide, which have been adjudged, either exprefsly or impliedly, malicious: thefe therefore may fuffice as a fpecimen; and we may take it for a general rule, that all homicide is malicious, and of courfe amounts to murder, unlefs where juftified by the command or permiffion of the law; excufed on a principle of accident or felf-prefervation; or alleviated into manflaughter, by being either the involuntary confequence of fome act, not ftrictly lawful, or (if voluntary) occafioned by fome fudden and fufficiently violent provocation. And all thefe circumftances of juftification, excufe, or alleviation, it is incumbent upon the prifoner to make out, to the fatisfaction of the court and jury: the latter of whom are to decide whether the circumftances alleged are proved to have actually exifted; the former, how far they extend to take away or mitigate the guilt. For all homicide is prefumed to be malicious, until the contrary appeareth upon evidence.

The punifhment of murder, and that of manflaughter,

slaughter, were formerly one and the same; both having the benefit of clergy: so that none but unlearned persons, who least knew the guilt of it, were put to death for this enormous crime. But now, by several statutes, the benefit of clergy is taken away from murderers through malice prepense, their abettors, procurers, and counsellors. In atrocious cases it was frequently usual for the court to direct the murderer, after execution, to be hung upon a gibbet in chains near the place where the fact was committed; but this was no part of the legal judgment; and the like is still sometimes practised in the case of notorious thieves. This, being quite contrary to the express command of the mosaical law, seems to have been borrowed from the civil law; which, besides the terror of the example, gives also another reason for this practice, viz. that it is a comfortable sight to the relations and friends of the deceased. But now, in England, it is enacted by statute 25 Geo. II. c. 37. that the judge, before whom any person is found guilty of wilful murder, shall pronounce sentence immediately after conviction, unless he sees cause to postpone it; and shall in passing sentence direct him to be executed on the next day but one (unless the same shall be Sunday, and then on the Monday following), and that his body be delivered to the surgeons to be dissected and anatomized; and that the judge may direct his body to be afterwards hung in chains, but in nowise to be buried without dissection. And, during the short but awful interval between sentence and execution, the prisoner shall be kept alone, and sustained with only bread and water. But a power is allowed to the judge, upon good and sufficient cause, to respite the execution, and relax the other restraints of this act. See further, PARRICIDE, and PETIT *Treason*.

MURDERERS, or *Murdering Pieces*, in a ship, are small pieces of ordnance, either of brass or iron, which have chambers put in at their breeches. They are used at the bulk-heads of the fore-castle, half-deck, or steerage, in order to clear the deck, on the ship's beind boarded by an enemy.

MURENA. See MURÆNA.

MURENGERS, two officers of great antiquity in the city of Chester, annually chosen out of the aldermen, to see that the walls are kept in repair, and to receive a certain toll and custom for the maintenance thereof.

MURET (Mark Anthony Francis) in Latin *Muretus*, was born at Muret, near Limoges, in 1526. He acquired a perfect knowledge of the Greek and Latin tongues without any instructor, and became one of the most learned men of his time. After having taught some time in Provence, he was made a professor at Paris in the same college with Turnebus and Buchanan. In 1554, he went into Italy; and in 1563 was professor of law, philosophy, and history, at Rome, where he died in 1585. His principal works are, 1. Excellent notes on Terence, Horace, Catullus, Tacitus, Cicero, Sallust, Aristotle, Xenophon, &c. 2. *Orationes*. 3. *Variæ Lectiones, Poemata, Hymni Sacri*. 4. *Disputationes in Lib. I. Pandectorum, de Origine Juris, &c.* 5. *Epistolæ, Juvenilia Carmina, &c.* Most of Muret's works have been printed in the Venice edition of 1737, in 5 vols 8vo.

MUREX, in zoology, a genus of insects belonging to the order of vermes testacea. This animal is of the snail-kind: the shell consists of one spiral valve, rough, with membranaceous furrows; and the aperture terminates in an entire canal, either streight, or somewhat ascending. There are 60 species, particularly distinguished by peculiarities in their shells, &c.

From a species of murex was obtained the famous Tyrian dye so much valued by the ancients. This, however, has long been superseded by the use of the cochineal. One of the shells producing the dye was a kind of buccinum; but the finest, or Tyrian purple, was got from the murex. These species of shells are found in various parts of the Mediterranean. Immense heaps of them are to be seen about Tarentum to this day, evincing one place where this precious liquor was extracted. See Plate CLXXVI. fig. 1.

In the accounts of a Spanish philosopher it is mentioned, that on the coasts of Guayaquil and Guatimala in Peru the murex is also found. The shell which contains it adheres to the rocks that are washed by the sea: it is of the size of a large walnut. The liquor may be extracted two ways; some kill the animal after they have drawn it out of the shell; then press it with a knife from head to tail; separate from the body the part where the liquor is collected, and throw away the rest. When this operation, after being repeated on several snails, has afforded a certain quantity of fluid, the thread intended to be dyed is dipped in it, and the process is finished. The colour, which is at first of the whiteness of milk, becomes afterwards green, and is not purple till the thread is dry. Those who disapprove of this method, draw the fish partly out of the shell, and, squeezing it, make it yield a fluid which serves for dying: they repeat this operation four times at different intervals, but always with less success. If they continue it, the fish dies. No colour at present known, says the abbé Raynal, can be compared to this, either as to lustre, liveliness, or duration. It succeeds better on cotton than wool, linen, or silk.

MURIA, *Alimentary salt*. See SALT.

MURRAIN, or GARGLE, a contagious disease among cattle. The symptoms are, a hanging down and swelling of the head, abundance of gum in the eyes, rattling in the throat, a short breath, palpitation at the heart, staggering, a hot breath, and a shining tongue. In order to prevent this disease, the cattle should stand cool in summer, and have plenty of good water: all carrion should be speedily buried; and as the feeding of cattle in wet places, on rotten grass and hay, often occasions this disease, dry and sweet fodder should be given them.

MURRAY, a county of Scotland, extending by the coast from the river Spey on the east to Beauly on the west, which is the boundary of the province of Ross; and comprehending the countries of Stathspey, Badenoch, Strathern, Srathnairn, and Strathnerick.

According to the account of the reverend Mr Shaw minister of Elgin, in answer to some queries of Mr Pennant, the country produces wheat, barley, oats, rye, pease, and beans. Of these, in plentiful years, upwards of 20,000 bolls are exported, besides serving the

Murray. the country itfelf and fome of the Highland countries. Some hemp is alfo cultivated, and a great deal of flax; of which linen is made, not only for home-confumption, but a confiderable quantity of linen-yarn is exported. Great quantities of potatoes are alfo cultivated. Several hundreds of black cattle alfo are exported from the Highlands of Murray, but few or none from the Lowlands.—Peculiar to this province is a kind of wood, called *red faugh*, or *fallow;* which is no lefs beautiful than mahogony. It is much more firm and tough than mahogony, and refembles the lighter-coloured kind of that wood. It receives a fine polifh, but is very fcarce, growing on rocks. But there are great forefts of firs and birches, which our author thinks are the remains of the Sylva Caledonia. Here alfo is found a remarkable root, called by the natives *carmele:* it grows in heaths and birch-woods to the bignefs of a large nut; and fometimes there are four or five roots joined together by fibres. It has a green ftalk, and fmall red flowers. Dio, fpeaking of of the Caledonians, fays, *Certum cibi genus parant ad omnia, quem fi ceperint quantum eft unius fabæ magnitudo, minime efurire aut fitire folent.* Cæfar alfo tells us of a root called *chara*, which his foldiers mixed with milk and made into bread when in want of provifion, which greatly relieved them. This root, Mr Shaw thinks, is the fame with the *carmele*, or *fweet root* of Murray. He informs us, that he hath often feen it dried, and kept for journeys through hills where no provifion was to be had: he has likewife feen it pounded and infufed; the liquor makes a more agreeable and wholefome liquor than mead. It grows in fuch plenty, that a cart-load of it can eafily be gathered.

Murray is interfected by the rivers Spey, Loffey, Findern, Nairn, Nefs, and Beauly. The river of Spey, rifing on the borders of Lochaber, is more than 60 Scots, or 100 Englifh miles long, but too rapid to be navigable. Upon this river great floats of fir and birch-wood are carried down to the Frith; the float is guided by a man fitting on a *courach*. This veffel is of an oval fhape, about four feet long and three broad; a fmall keel from head to ftern; a few ribs crofs the keel, and a ring of pliable wood round the lip of it; the whole covered with the rough hide of an ox or horfe. The rower fits on a tranfverfe feat in the middle, and holds in his hand a rope, the end of which is tied to the float, and with the other hand he manages a paddle, keeps the float in deep water, and brings it to fhore when he pleafes. In this province, alfo, is Loch Nefs, remarkable for its never freezing. There are many other lakes in this country, of which one called *Dundelchack* is remarkable in that it is never covered with ice before the month of January; but after that time one night's ftrong froft covers it all over. On the eaft fide of Loch Nefs, a large mile above the loch, is the waterfall of Foher, where the river *Feach-Len* falls over a fteep rock about 80 feet high; and a thick fog rifes from the place where it falls, occafioned by the violent dafhing of the water. There is a confiderable falmon-fifhery on the rivers Spey, Findern, Nefs, and Beauly, which ferves the towns and country, befides exporting to the value of 12,000 l. annually.

There are many natural caves in the hills of this country, which formerly were the receptacles of thieves and robbers, and now afford fhelter to hunters and fhepherds in ftormy weather. The moft remarkable mountain is *Carngern*, in Strathfpey. In it are found a particular kind of ftones well known to the lapidaries. They are of blue, green, yellow, and amber colours; fome fo large as to make fnuff-boxes, or fmall cups; fome of hexagonal or pentagonal figures, and tapering to a point at each end. The mountain of Benalar, in Badenoch, is by Mr Shaw reckoned to be the higheft land in Scotland, as waters flowing from it fall into the fea at Dundee, Inverlochy, and Garmoch in Murray.

Mus. MUS, in zoology, a genus of quadrupeds, belonging to the order of glires; the genuine character of which is, that the fore-teeth of the lower jaws are fubulated. There are fpecies.

1. The porcellus, or Guiney-pig, fo called from its being fuppofed to come only from Guinea, is a native of Brafil as well as Guinea. It is about the fize of a young pig, and hath erect hair not unlike it. The colour is white or white varied with orange and black in irregular blotches; hath no tail, but very large broad ears rounded at the fides. Thefe animals are of fuch a hot conftitution, that they copulate five or fix weeks after birth. They acquire not, however, their full growth before the eighth or ninth month. But this increafe of fize confifts only of fat; for the folid parts are fully unfolded before the age of fix months. The females go with young only three weeks: the firft litter confifts of four or five; the fecond of five or fix; and the fucceeding ones of feven or eight, and fometimes of 10 or 12. The mother fuckles her young 12 or 15 days: fhe banifhes them as foon as fhe receives the male, which happens at fartheft three weeks after her delivery; and if any of them perfift in following her, they are maltreated and killed by the male. As they breed fo faft, their multitudes would be innumerable, if there were not fo many enemies which deftroy them. They cannot refift either cold or moifture; when cold, they affemble and crowd clofe together, in which cafe they often all perifh together. They are alfo devoured in great numbers by cats, and many are killed by the males. Though perpetually throwing out urine, they never drink. They feed on all kinds of herbs; but efpecially on parfley, which they prefer to grain or bread; and they are likewife fond of apples and other fruits. They eat precipitately like the rabbit, little at a time, but very often; make a grunting noife like a little pig, and are very reftlefs. No mention is made by natural hiftorians of the manners of this animal in a wild ftate. Their fkin is hardly of any value; and their flefh, though eatable, is not fo good as to be much demanded: but it might be improved by keeping them in warrens, where they would have the benefit of the frefh air, and the liberty of choofing herbs agreeable to their tafte. Thofe kept in houfes have nearly the fame bad tafte with warren-rabbits; and thofe kept in gardens during the fummer, have an infipid, but lefs difagreeable flavour.

2. The aguti, is about the fize of a hare, has a fhort tail; four toes on the fore-feet, three on the hind ones; and a yellowifh belly. According to M. Buffon, it is an animal peculiar to the fouthern parts of America, being

Plate CLXXXIII.

Fig. 1. Mus Porcellus *or* *Guiney Pig*

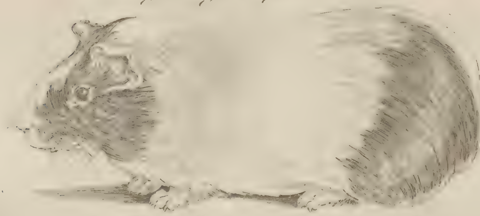


Fig. 2. Mus Aguti

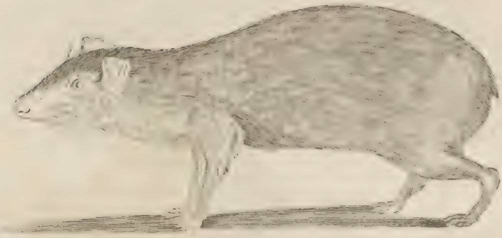


Fig. 4

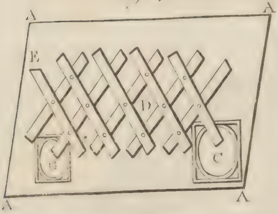
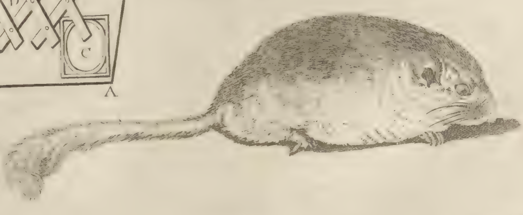


Fig. 3.

Mus Avellonarius



A. Bell Sculp.t

Plate CLXXXIV

Fig. 1. Mus Marmotta or Alpin mouse.

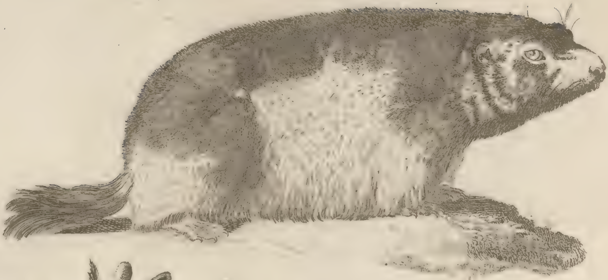


Fig. 2. Mus Jaculus.

Fig. 3. Mus Lemmus.

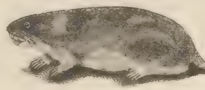


Fig. 4. Mustela Lutra or Otter.

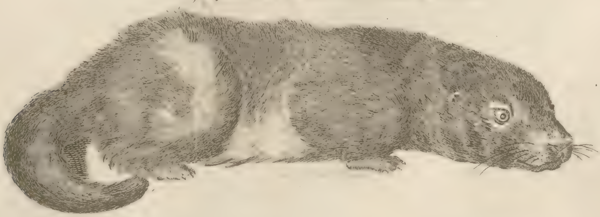


Fig. 5. Mud-Inguina See Next Plate.

A. Bell Sculp.

Mus. ing never found in the old world. It is common in Brafil, Guiana, St Domingo, and all the iflands; and feems to require a warm climate in order to fubfift and multiply. However, they can live in France, if kept in a dry place, and fheltered from winter-frofts. The aguti is a very mifchievous animal, and bites cruelly: he grunts like a pig; is very voracious; fits on his hind-legs, and holds his food with the fore-feet when he eats: hides what he cannot confume: hops like a hare, and runs very faft both on plain and rifing grounds; but as his fore-legs are much fhorter than the hind-ones, he would tumble headlong if he did not flacken his courfe in defcending. Both his eye and his ear are fine; he ftops and liftens to the found of mufic: the flefh of thofe which are fat and well-fed is not very bad, though it be hard, and not very agreeable to the tafte. They fcald the aguti, and make him ready in the fame manner as a pig. He is hunted with dogs. When forced among the cut fugar-canes, he is foon taken; becaufe thefe grounds being generally covered a foot thick with ftraw and leaves, at each leap he finks in this litter, fo that a man may overtake and flay him with a baton. He commonly runs very nimbly before the dogs; and when he gains his retreat, he lies fquat, and remains obftinately in his concealment. The hunters are obliged to chace him out by filling his hole with fmoke. The animal, half fuffocated, utters mournful cries; but never iffues forth, unlefs when pufhed to the laft extremity. His cry, which he often repeats when difturbed or irritated, refembles that of a fmall hog. If taken young, he is eafily tamed, and goes out and returns of his own accord. Thefe animals commonly refide in the woods and hedges; where the females choofe a place well covered and bufhy, and there prepare a bed of leaves and hay for their young. They annually produce two or three, but generally two. Like the cats, they tranfport their young, two or three days after birth, into the hollows of trees, where they fuckle them for a fhort time; the young are foon in a condition to follow their mother, and to fearch for food.

Plate CLXXXIII fig. 2.

3. The leporinus, or Java hare, is about the fize of an ordinary hare: the hair of a reddifh brown-colour; the head fmall in proportion to the body; the eyes large and prominent; the ears like thofe of a rat; in other refpects the head refembles both a deer and hare; the hind-part of the body and thighs remarkably big; the legs long; four toes on the fore-feet, and three on the hind-feet: is a native of Java and Sumatra. The above defcription was taken from an an animal of this kind in the poffeffion of the duke of Richmond. It was very tame and inoffenfive, and fed only on fruit and other vegetables.

Plate CLXXXII. fig. 6

4. The citellus, or earlefs marmot, hath a fhort tail, an afh-coloured body, and no ears. It inhabits Bohemia, Auftria, Hungary, and Siberia. It hath been confounded with the cricetus, or hamfter; but, according to M. Buffon, the differences between them are very confpicuous, chiefly in the want of ears in the citellus; for though the ears of the hamfter are fhort, they are broad, and very obfervable; the citellus alfo never copulates with the hamfter, which is fufficient to remove every doubt with regard to the diverfity of their fpecies. This creature burrows, and forms its magazine of corn, nuts, &c. for its winter-food. It fits up like a fquirrel. By Gmelin's account, fome inhabit the fields in Siberia, others penetrate into granaries; the former make holes in the ground with a double entrance, and fleep during winter in the centre of their lodge: thofe which inhabit the granaries are in motion during the whole of the cold feafon. They couple in the beginning of May, and bring from five to eight young, which they bring up in their burrows, and cover with hay. They whiftle like the marmot; are very irafcible, and bite very feverely: their furs were once ufed by the ladies of Bohemia to make cloaks. Mus.

5. The lemmus, or lemming, hath a fhort tail, five toes on both fore and hind feet, and the body is variegated with green and yellow. This creature, which is one of the moft fingular that we know of, is faid to be a native of the mountains of Kolin in Lapland. They appear not every year; but at certain unforefeen periods they come in fuch numbers, that they fpread every where, and cover the whole furface of the earth. The arrival of the lemmings is confidered as a terrible fcourge, the effects of which it is impoffible to avoid. They make dreadful devaftations in the fields; lay wafte the gardens; ruin the crops; and leave nothing, except what is fhut up in houfes, where they never enter. They bark nearly like fmall dogs. When attacked, they neither fear clubs nor halberds, but dart againft thofe who ftrike them, outrageoufly biting, and fixing upon the weapons employed to kill them. When ftruck at with a ftick, they feize it fo forcibly with their teeth, that they allow themfelves to be carried to a confiderable diftance without quitting their hold. They dig holes in the earth, and make roads like the moles, in queft of roots. They fometimes make war, and divide themfelves into two armies along the lakes and meadows. Their enemies are foxes and ermines, who devour great numbers of them. Grafs that has been ate down, and fprings again, is faid to kill them: and they feem likewife to commit fuicide; for they are often found fufpended on the branches of trees; and they probably throw themfelves in troops into the waters like the fwallows. It would alfo appear, that the lemmings, like the rats, mutually deftroy and eat each other, when pafture fails them; and that this is the reafon why their deftruction is as fudden as their multiplication. At particular times they affemble together, and the whole die in company. They are very courageous, and defend themfelves againft other animals. It is not certainly known whence they come. The vulgar believe that they fall from the clouds along with the rain. Upon the renewal of the grafs they infallibly die. In fine weather they take to the water in vaft multitudes; but when a breeze of wind arifes, they are all drowned. The number of thefe animals is fo prodigious, that when they die the air is infected, and produces many difeafes. They even feem to infect the plants which they gnaw; for the pafture then kills the cattle. The flefh of the lemmings is not good to eat; and their fkin, though the hair be fine, does not anfwer for making furs, becaufe it is too thick. Plate CLXXXIV fig. 3.

6. The paca, or fpotted cavy, is an animal peculiar to the new world, particularly Brazil. It has a fhort tail, five toes on each foot, and three yellowifh lines on each fide. It refembles a pig of two months old; and its flefh is fat, and makes excellent food.

Even the ſkin is eat, like that of a pig. For theſe reaſons this animal is in perpetual requeſt. It is difficult for the hunters to take him alive. When ſurpriſed in his hole, which they lay open both before and behind, he defends himſelf, and even bites fiercely. His ſkin, though covered with coarſe ſhort hair, makes a very good fur, becauſe it is regularly ſpotted on both ſides. Theſe animals produce often and in great numbers; many of them are deſtroyed by men and beaſts of prey, and yet the ſpecies is always numerous.

When kept in a wooden cage or box, this animal remains perfectly tranquil during the day, eſpecially when plentifully ſupplied with food. He ſeems even to have an affection for his retreat as long as the day laſts; for, after feeding, he retires ſpontaneouſly into it. But when night approaches, by perpetual reſtleſſneſs and agitation, and by tearing the bars of his priſon with his teeth, he diſcovers a violent deſire of getting out. Nothing of this kind happens during the day, unleſs he has occaſion for ſome natural evacuation; for he cannot endure the ſmalleſt degree of dirtineſs in his little apartment; and when about to void his excrements, always retires to the moſt diſtant corner he can find. When his ſtraw begins to ſmell, he often throws it out, as if he meant to demand freſh litter. This old ſtraw he puſhes out with his muzzle, and goes in queſt of rags or paper to replace it. In a female cavy, the following extraordinary inſtance of cleanlineſs was obſerved. A large male rabbit being ſhut up with her when ſhe was in ſeaſon, ſhe took an averſion to him the moment he voided his excrement in their common apartment. Before this ſhe was very fond of him; licked his noſe, ears, and body; and allowed him to take almoſt the whole food that was given her. But as ſoon as the rabbit had infected the cage with his ordure, ſhe retired into the bottom of an old preſs, where ſhe made a bed with paper and rags, and returned not to her old lodging, till ſhe ſaw it neat, and freed from the unclean gueſt which had been preſented to her.

The ſpotted cavy is eaſily accuſtomed to a domeſtic life. Unleſs induſtriouſly irritated, he is gentle and tractable. He is fond of adulation, and licks the hands of the perſon who careſſes him. He knows thoſe who take care of him, and readily diſtinguiſhes their voices. When gently ſtroaked on the back, he ſtretches himſelf out, lies down on his belly, by a ſmall cry expreſſes his acknowledgment, and ſeems to aſk a continuance of the favour. When ſeized in a rough manner, however, he makes very violent efforts to eſcape.

Plate CLXXXIV fig. 1.

7. The marmota, or marmot, has a ſhort hairy tail, round ears, and gibbous cheeks. It is found only on the tops of the higheſt mountains, and is more ſubject to be rendered torpid by cold than any other. In the end of September, or beginning of October, he retires into his hole, from which he comes not out till the beginning of April. His retreat is capacious, broader than long, and very deep, ſo that it can contain ſeveral marmots, without any danger of corrupting the air. With their feet and claws, which are admirably adapted for the purpoſe, they dig the earth with ſurpriſing quickneſs, and throw it behind them. It is not a hole, or a ſtraight or winding tube, but a ſpecies of gallery made in the form of a Y, each branch of which has an aperture, and both terminate in one where the animal lodges. As the whole is made on the declivity of a mountain, the innermoſt part alone is on a level. Both branches of the Y are inclined, and the one is uſed for depoſiting the excrements of the animals, and the other for their going out and coming in. The place of their abode is well lined with moſs and hay, of which they make ample proviſion during the ſummer. It is even affirmed, that this labour is carried on jointly; that ſome cut the fineſt herbage, which is collected by others, and that they alternately ſerve as vehicles for tranſporting it to their dens. One, it is ſaid, lies down on his back, allows himſelf to be loaded with hay, extends his limbs, and others trail him in this manner by the tail, taking care not to overſet him. Theſe repeated frictions are aſſigned as the reaſon why the hair is generally rubbed off their backs. But it is more probable, that this effect is produced by their frequent digging of the earth. But, whatever may be in this, it is certain that they dwell together, and work in common at their habitations, where they paſs three-fourths of their lives. Thither they retire during rain, or upon the approach of danger; and never go out but in fine weather, and even then to no great diſtance. One ſtands centinel upon a rock, while the others ſport on the graſs, or are employed in cutting it to make hay. When the ſentinel perceives a man, an eagle, a dog, &c. he alarms the reſt with a loud whiſtle, and is himſelf the laſt to enter the hole. They make no proviſions for winter; nor have they in that ſeaſon any occaſion for them, as lying aſleep all that time. As ſoon as they perceive the firſt approaches of the ſleeping ſeaſon, they ſet to work in ſhutting up the two entrances of their habitation; and this they perform with ſuch labour and ſolidity, that it is eaſier to dig the earth any where elſe than in the parts they have fortified. They are at this time very fat, weighing ſometimes 20 pounds; and they continue to be plump for three months; but afterwards they gradually decay, and are extremely emaciated at the end of winter. When diſcovered in their retreats, they are found rolled up in the form of a ball, covered with hay; and they are carried off in ſo torpid a ſtate, that they may be killed without ſeeming to feel pain. The fatteſt are choſen for eating, and the young ones for taming. When taken young, they may be rendered nearly as tame as our other domeſtic animals. They learn to ſeize a ſtick, to dance, to perform various geſticulations, and to obey the voice of their maſter. Like the cat, the marmot has an antipathy againſt dogs. When he begins to be familiar in the houſe, and perceives that he is protected by his maſter, he attacks and bites dogs of the moſt formidable kind. Though not ſo large as a hare, he is ſtouter, and his ſtrength is aided by a peculiar ſuppleneſs and dexterity. With his fore-teeth, which are pretty long, he bites moſt cruelly; he attacks not, however, either dogs or men, unleſs previouſly irritated. If not prevented, he gnaws furniture and ſtuffs; and when confined, pierces even through wood. His voice reſembles the murmuring of a young dog when careſſed or in a ſporting humour; but, when irritated or frighted, he makes a whiſtling noiſe, ſo loud and piercing, that it hurts the ear. The marmots eat every thing preſented to them; as fleſh, bread, fruit, roots, pot-herbs, may-bugs, graſhoppers, &c. but milk and butter they prefer to every

every other aliment. Though lefs inclined to theft than the cat, they endeavour to flip into the dairy, where they drink great quantities of milk, making, like the cat, a murmuring noife expreffive of pleafure. Milk is alfo the only liquor that is agreeable to them; for they rarely drink water; and they refufe wine. They produce but once a-year, and the litter generally confifts of three or four. The growth of their young is very quick; they live only nine or ten years; and the fpecies is neither numerous nor much diffufed. The marmot would make very good eating, if it had not always a difagreeable flavour, which cannot be concealed but by ftrong feafonings.

8. The monax, or marmot of Canada, has a hairy tail, an afh-coloured body, roundifh ears, and four toes on the fore-feet, and five on the hind-ones. It is a native of America, and differs very little from the former.

9. The circetus, hamfter, or German marmot, is the moft famous as well as the moft deftructive of all the rats. It has a tail of a moderate length, round ears, a black belly, and reddifh fides, with three white fpots. This creature fleeps during the winter like the marmots; when in a torpid ftate, neither refpiration, nor any kind of feeling, can be perceived. The heart, however, beats 15 times in a minute, which has been difcovered by opening the cheft. The blood continues to be fluid, but the inteftines are not irritable; even an electrical fhock does not awake him; but in the open air he never becomes torpid. When dug up in his ftate of torpidity, the hamfter is found with his head bent under his belly between the two fore-legs, and thofe behind reft upon his muzzle. The eyes are fhut; and when the eye-lids are forced open, they inftantly clofe again. The members are ftiff, like thofe of a dead animal, and the whole body feels as cold as ice. When diffected during this ftate, he feems to feel very little; fometimes indeed he opens his mouth as if he wanted to refpire; but his lethargy is too ftrong to admit of his awakening entirely. This lethargy hath been afcribed folely to a certain degree of cold; which indeed may be true with regard to dormice, bats, &c. But experience fhews, that, in order to render the hamfter torpid, he muft alfo be excluded from all communication with the external air: for when he is fhut up in a cage filled with earth and ftraw, and expofed in winter to a degree of cold fufficient to freeze the water, he never becomes torpid: but when the cage is funk four or five feet under ground, and well fecured againft the accefs of the air, at the end of eight or ten days he is equally torpid as if he had been in his own burrow. If the cage is brought up to the furface, the hamfter will awake in a few hours, and refume his torpid ftate when put below the earth. The experiment may be repeated with the fame fuccefs as long as the froft continues. We have a farther proof that the abfence of the air is one of the caufes of torpidity in the hamfter; for when brought up from his hole in the coldeft weather, and expofed to the air, he infallibly awakes in a few hours. This experiment fucceeds as well in the night as in the day; which fhews that light has no fhare in producing the effect. It is curious to obferve the hamfter paffing from a torpid to an active ftate. He firft lofes the rigidity of his members, and then makes a profound refpiration, but at long intervals. His legs begins to move, he opens his mouth, and utters difagreeable and rattling founds. After continuing thefe operations for fome time, he opens his eyes, and endeavours to raife himfelf on his legs. But all thefe movements are ftill reeling and unfteady, like thofe of a man intoxicated with liquor. He, however, reiterates his efforts till he is enabled to ftand on his legs. In this attitude he remains fixed, as if he meant to reconnoitre and repofe himfelf after his fatigue; but he gradually begins to walk, eat, and act in his ufual manner. This paffage from a torpid to an active ftate, requires more or lefs time, according to the temperature of the air. When expofed to a cold air, he fometimes requires more than two hours to awake; and in a more temperate air he accomplifhes his purpofe in lefs than one hour. It is probable that, when the hamfter is in his hole, this change is performed imperceptibly, and that he feels none of the inconveniencies which arife from a fudden and forced revivifcence.

The hamfter is a very mifchievous animal; and fo exceedingly fierce, that he feems to have no other paffion but rage. In confequence of this, he attacks every other animal that comes in his way, without regarding the fuperior fize or ftrength of his antagonift; nay, as if he was ignorant of the method of faving himfelf by flight, he allows himfelf to be beat to pieces with a ftick, rather than yield. If he feizes a man's hand, he muft be killed before he quits his hold. When the hamfter perceives a dog at a diftance, he begins with emptying his cheek-pouches if they happen to be filled with grain, and which are fo capacious as to hold a quarter of a pint Englifh. He then blows them up fo prodigioufly, that the fize of the head and neck greatly exceeds that of the body. Laftly, he raifes himfelf on his hind-legs, and in this attitude darts on his enemy. If he catches hold, he never quits it but with the lofs of life. But the dog generally feizes him behind, and ftrangles him. This ferocious temper prevents the hamfter from being at peace with any other animal. He even makes war againft his own fpecies, not excepting the females. When two hamfters encounter, they never fail to attack each other, and the ftronger always devours the weaker. A combat between a male and a female lafts longer than between two males. They begin by purfuing and biting each other; then each of them retires to a fide as if to take breath; a little after, they renew the combat, and continue to fly and to fight till one of them falls. The vanquifhed uniformly ferves for a repaft to the conqueror.

The hamfters copulate about the end of April; when the males enter the apartments of the females, where they remain only a few days. If two males happen to meet in the fame hole, a furious combat enfues, which generally terminates in the death of the weakeft. The conqueror takes poffeffion of the female, and both, though at every other period they perfecute and kill each other, lay afide their natural ferocity during the few days their amours continue. They even mutually defend each other againft agreffors; and if a hole is opened about this time, the female defends her hufband with the utmoft fury. The females bring forth twice or thrice every year. Their litter is never fewer than fix, and more frequently than

Mus. from 16 to 18. Their growth is very rapid. At the age of 15 days they begin to dig the earth; and foon after, the mother banifhes them from her habitation; fo that at the age of about three weeks they are abandoned to their own management. The mother in general difcovers little affection for her offfpring; and when her hole is opened, flies in the moft daftardly manner, leaving her young ones to perifh. Her only folicitude at that time is to provide for her own defence. With this view fhe digs deeper into the earth, which fhe performs with amazing quicknefs. The young would willingly follow her; but fhe is deaf to their cries, and even fhuts the hole which fhe had made.

As the hamfter lives on grains, and dwells under the earth, fome kinds of foils are inconvenient for him. He requires a foil which is eafily pierced, and yet fo tenacious as not to tumble down. Stony, fandy, and argillaceous foils, are therefore improper, as well as meadows, forefts, and marfhy grounds. He likewife choofes countries which abound in all kinds of grain, that he may not be obliged to feek his food at great diftances. In Thuringia, the foil of which poffeffes all thefe qualities, the hamfters are more numerous than in any other country. The habitations are dug to the depth of three or four feet, and confift of more or fewer apartments, according to the age of the animal. The principal apartment is lined with ftraw, and ferves him for a lodging. The others are deftined for the prefervation of provifions, of which he amaffes great quantities during the autumn. Each hole has two apertures: the one defcends obliquely; and the other, through which the animal goes out and in, is perpendicular. The holes of the females, who never live with the males, are fomewhat different. In thofe where fhe brings forth, there is feldom above one chamber for provifions; becaufe the fhort time the young remain with her requires not a great ftore of food. But inftead of one perpendicular hole, fhe makes feven or eight, to give free paffage to her young. Sometimes the mother banifhes her offspring, and continues to poffefs this hole; but fhe commonly digs another, and lays up as much provifions as the feafon permits her to collect.

The hamfter feeds upon all kinds of herbs, roots, and grains, which the different feafons produce. He even eats the flefh of fuch animals as he can conquer. As he is not adapted for long journeys, his magazine is firft ftocked with the provifions which are neareft his abode. This is the reafon why fome of his chambers are frequently filled with one kind of grain only. When the harveft is reaped, he goes to a greater diftance in queft of provifions, and carries every article he can find, without diftinction, to his granary. To facilitate the tranfportation of his food, nature has furnifhed him with two pouches in the infide of each cheek. On the outfide, thefe pouches are membranous, fmooth, and fhining; and in the infide there are a great many glands, which fecrete a certain fluid, to preferve the flexibility of the parts, and to enable them to refift any accidents which may be occafioned by the roughnefs or fharpnefs of particular grains. Each of thefe receptacles is capable of containing an ounce and an half of grain, which, on his return to his lodging, he empties, by preffing his two fore-feet againft his cheeks. When we meet a hamfter having his cheeks filled with provifions, it is eafy to feize him with the hand, without the rifk of being bitten; becaufe in this condition he has not the free motion of his jaws. But if he is allowed a little time, he foon empties his pouches, and ftands upon his defence. The quantity of provifions found in the holes depends on the age and fex of the inhabitant. The old hamfters frequently amafs 100 pounds of grain; but the young, and the females, content themfelves with a quantity much fmaller. Their object in laying up provifions, is not to nourifh them during winter, which they pafs in fleep, and without eating; but to fupport them after they awake in the fpring, and previous to their falling into a torpid ftate, which refembles a profound fleep. At the approach of winter, the hamfters retire into their fubterraneous abodes, the entrance to which they fhut up with great addrefs. Here the animal repofes, in the fituation already defcribed, upon a bed of ftraw; and in this ftate he is commonly dug up. In winter the peafants generally go a *hamfter-nefting* as they call it; the retreat is known by a fmall emineuce of earth raifed near the oblique paffage formerly defcribed. The peafants dig down till they difcover the hoard, and are generally well paid for their trouble; as they often find two bufhels of corn, befides the fkins of the animals, which are valuable furs; and it is remarkable that the hair fticks fo faft to the fkin, that it cannot be plucked off without the utmoft difficulty. In fome feafons the hamfters are fo numerous, that they occafion a dearth of corn. Pole-cats are their greateft enemies; for they purfue them into their holes, and deftroy great numbers.

10. The terreftris, or fhort-tailed field-moufe, has a hairy tail, with four toes on the fore-feet, and five on the hind-ones, and ears fhorter than the hair. It inhabits Europe, and is found in great numbers in Newfoundland. It digs holes in the earth, where it amaffes grain, filberts, and acorns: but it appears to prefer corn to every other food. When the grain is ripe, the fhort-tailed field-mice affemble from all quarters, and often do great damage by cutting the ftalks of corn, in order to come at the ears. They follow the reapers, and eat up all the fallen and neglected grain. When the gleanings are devoured, they flock to the new-fown fields, and deftroy the crop of the enfuing year. In winter moft of them retire into the woods, where they feed upon filberts, acorns, and the feeds of trees. In particular years they appear in numbers fo immenfe, that they would deftroy every thing if they continued long: but they always kill and eat one another during a fcarcity of provifions. They befides are devoured by the long-tailed field-mice, by foxes, wild-cats, and weafels. Thefe creatures are often carried home in the fheaves of corn; and 100 of them have been found in houfing a rick. In fuch cafes it hath been obferved, that the dogs devoured all the mice of this fort they could find, rejecting the common kind; and, on the contrary, the cats would touch none but the laft. This animal makes its neft in moift meadows, and brings eight young at a time: it has a ftrong affection for them; one that was feduced into a wire-trap by placing its brood in it, was fo intent on foftering them, that it appeared quite regardlefs of its captivity. In Newfoundland, thefe mice

mice are very deftructive to gardens; but feldom do much damage in this way in Britain.

11. The amphibius, or water-rat, has a long hairy tail, but not palmated feet, as is faid by Linnæus. It is about the fize of a rat, but in its manners refembles the otter much more than the rat. Like the otter, it frequents the frefh water, and is found on the banks of rivers, brooks, and pools. Gudgeons, minnows, blays, and the fry of carps, pikes, and barbels, are its ordinary food. It likewife eats frogs, water-infects, and fometimes the roots of plants. He fwims with great eafe, keeps long under water, and carries off his prey to be devoured on the grafs or in his hole. He is fometimes furprifed by the fifhermen when fearching for craw-fifh; and he endeavours to efcape by biting their fingers, or leaping into the water. Like the otter, he avoids large rivers, or rather thofe which are much frequented. He never vifits houfes or barns; but keeps upon the margins of waters, from which he wanders not upon dry land fo far as the otter, who is fometimes found at the diftance of a league from water. Water-rats are feldom met with in elevated places or dry plains, but are extremely numerous in moift and marfhy valleys. The females come in feafon about the end of winter, and bring forth in the month of April, the litter generally confifting of fix or feven. Perhaps they bring forth more than once a-year; but of this we have no proper knowledge. This animal, as well as the otter, is eaten by the French peafants on *maigre*-days. Water-rats are found all over Europe, excepting in the polar regions. According to Bellon, they inhabit the banks of the Nile; but the figure he gives of them has fo little refemblance to our water-rat, that it is probable the Nile-rats belong to another fpecies of animals.

12. The rattus, or common rat, is the moft pernicious of any of our fmaller quadrupeds. Meat, corn, paper, cloaths, furniture, in fhort every conveniency of life, is a prey to this deftructive creature. Nor are its devaftations confined to thefe; for it will make equal havock among poultry, rabbits, or young game; nay, it hath been known to gnaw the extremities of infants when afleep. It is a domeftic animal, refiding very frequently in houfes, barns, or granaries; and it is furnifhed with fore-teeth of fuch ftrength as enable it to force its way through the hardeft wood or the oldeft morter. Several fmall animals have been confounded under the general name of *rat;* but the appellation feems properly to belong only to two; namely, the common black, and the brown rats. The black rats are not of a perfectly black colour, but of a deep iron grey, with an afh-coloured belly, the legs dufky, and almoft naked; they have a claw, in the place of a fifth toe, on the fore-feet; the length from the nofe to the tail feven inches, the tail nearly eight. It inhabits moft parts of Europe, but of late the numbers have been very much leffened by the other kind. It makes a lodge either for its day's refidence, or a neft for its young, near a chimney; and improves the warmth of it, by forming there a magazine of wool, bits of cloth, hay, or ftraw. It lodges alfo in cielings, and in the void fpaces between the wall and the wainfcotting. From thefe lurking places the rats iffue in queft of food, and tranfport thither every fubftance they can drag, forming confiderable magazines, efpecially when they have young to provide for. The female brings forth feveral times in a year, but always in the fummer-feafon. The litter generally confifts of five or fix; and in fpite of poifon, traps, and cats, they thus multiply to fuch a degree as fometimes to do a great deal of damage. In old country-houfes where grain is kept, and where the vicinity of barns and magazines facilitates their retreats, they often increafe fo prodigioufly, that the poffeffors are obliged to remove and defert their habitations, unlefs the rats happen to deftroy each other. This, however, frequently happens; for thefe creatures, when pinched for food, devour each other. When a famine happens by reafon of too many being crowded into one place, the ftrong kill the weak, open their heads, and firft eat the brain, and then the reft of the body. Next day the war is renewed, and continues in the fame manner till moft of them are deftroyed; which is the reafon why thefe animals, after being extremely troublefome for fome time, difappear all of a fudden, and do not return for a long time.

Rats are extremely lafcivious; they fqueak during their amours, and cry when they fight. They foon learn their young to eat; and when they begin to iffue from the hole, their mother watches, defends, and even fights with the cats, in order to fave them. A large rat is more mifchievous than a young cat, and nearly as ftrong; the rat ufes her fore-teeth, and the cat makes moft ufe of her claws; fo that fhe requires both to be vigorous, and accuftomed to fight, in order to deftroy her adverfary. The weafel, tho' fmaller, is a much more dangerous and formidable enemy to the rat, becaufe he can follow it into its retreat. Their ftrength being nearly equal, the combat often continues for a long time, but the method of ufing their arms is very different. The rat wounds only by reiterated ftrokes with his fore-teeth, which are better formed for gnawing than biting; and being fituated at the extremity of the lever or jaw, they have not much force. But the weafel bites cruelly with the whole jaw, and inftead of letting go its hold, fucks the blood from the wounded part, fo that the rat is always killed. The rat was firft introduced into America by the Europeans in 1544, and is now the peft of all that continent.

The brown or Norway rat is much larger than the black kind; being nine inches from the end of the nofe to the beginning of the tail; the length of the tail itfelf is the fame, the ufual weight 11 ounces. Notwithftanding its name, however, it is not known in Norway, nor in any part of Scandinavia. It was never known in Britain till about 45 years ago; and made its appearance in the neighbourhood of Paris only about 22 years ago. Mr Pennant fufpects, that this rat came originally in fhips from the Eaft Indies; a large brown fpecies being found there, called *bandicotes* by the natives, which burrow under ground. Barbot alfo mentions a fpecies inhabiting the fields in Guinea, and probably the fame with this. Wherever this creature has taken up its refidence, it hath totally extirpated the black kind: however, it is to be feared we fhall reap little benefit by the exchange; for the Norway rat hath the fame difpofition, with greater abilities for doing mifchief than the common kind. It burrows, like the water-rat, in the banks of rivers, ponds

ponds, and ditches; it takes the water very readily, and fwims and dives with great celerity: like the black fpecies, it preys on rabbits, poultry, and all kinds of game. It increafes moft amazingly faft, producing from 14 to 18 young at a time. Its bite is not only fevere but dangerous; the wound being immediately attended with great fwelling, and is a long time in healing. Thefe creatures are fo bold as to turn upon thofe who purfue them, and faften on the ftick or hand of fuch as offer to ftrike them.

13. The mufculus, or common moufe, has a long naked tail, four toes on the fore-feet, and five on the hind-feet, but no claw on the large toe. It has the fame inftinct, and the fame conftitution and natural difpofitions with the rat, differing only in the mere circumftances of fize and ftrength. The moufe never iffues from his hole but in queft of food, and runs in again upon the leaft alarm. He goes not, like the rat, from houfe to houfe, unlefs he be forced, and is not near fo deftructive. He is alfo capable of being tamed to a certain degree, though not fo perfectly as other animals. He hath many enemies, from whom he can efcape only by his agility and minutenefs. Owls, birds of prey, cats, weafels, and even rats, make war upon the mice, fo that they are deftroyed by millions; yet the fpecies ftill fubfifts by its amazing fecundity. They bring forth at all feafons, and feveral times in the year: the litter generally confifts of five or fix; and in lefs than 15 days the young difperfe, and are able to provide for themfelves. Ariftotle tells us, that having fhut up a pregnant moufe in a veffel, along with plenty of grain, he found in a fhort time after 120 mice, all fprung from the fame mother. All mice are whitifh under the belly, and fome are altogether white. Others are more or lefs brown and black. They are generally diffufed over Europe, Afia, and Africa; but it is alleged that they were introduced into America by the Europeans. It is certain, however, that this little animal follows man, and flies from uninhabited places; probably on account of its natural appetite for bread, cheefe, butter, &c. which men prepare for themfelves.

Plate CLXXXIII fig. 3.

14. The avellanarius, or dormoufe, is equal in fize to the former, but of a plumper appearance; the nofe is more blunt; the head, fides, belly and tail, are of a tawny red colour, the throat white. Dormice inhabit woods, or very thick hedges; forming their nefts in the hollow of fome low tree, or near the bottom of a clofe fhrub: they form little magazines of nuts, and eat in an upright pofture like the fquirrel. The confumption of their hoard, however, during the rigour of the feafon, is but fmall; for they fleep moft of the time, retiring into their holes; at the approach of winter, they roll themfelves up, and become torpid. Sometimes they experience a fhort revival in a warm funny day; when they take a little food, and relapfe into their former ftate. Thefe animals feldom appear far from their retreats, or in any open place; for which reafon they feem lefs common in Britain than they really are. They make their nefts of mofs, grafs, and dead leaves; and bring ufually three or four young at a time.

15. The quercinus, or garden-fquirrel, has a long hairy tail, with a black ring under the eyes. It is a native of the fouth of Europe, where it lives chiefly in gardens, though it fometimes is found in houfes. They are very deftructive to fruit, particularly peaches, which they feem to prefer to every other kind. They alfo eat peafe, apricots, and plumbs; and when foft fruits are not to be had, they will eat almonds, filberts, nuts, and even leguminous plants. Of thefe they carry off great quantities into their retreats, which they dig in the earth, and particularly in well cultivated gardens; for in old orchards they are often found in hollow trees, where they make beds of herbs, mofs, and leaves. Eight or ten of them are frequently found in the fame place, all benumbed, and rolled up in the midft of their provifion of fruits and nuts. They copulate in fpring, and bring forth in fummer. The litter confifts of five or fix young, who grow very quickly, but are not fertile till the next year. Their flefh is not eatable, but has the fame difagreeable odour with the domeftic rat.

16. The gregarius, or gregarious moufe, has a tail about one-third the length of its body, and fomewhat hairy; the body is of a greyifh colour, and the legs white. It is a native of Germany and Sweden, is fomewhat larger than the common moufe; eats fitting up; burrows, and lives under ground.

17. The fylvaticus, or long-tailed field-moufe, meafures, from the end of the nofe to the fetting on of the tail, four inches and an half; the tail is four inches long; the upper part of the body of a yellowifh-brown mixed with fome dufky hairs: the breaft is of an ochre colour, the reft of the under fide is white; the tail is covered with fhort hair. Thefe animals are found only in fields and gardens; in fome places they are called *bean-mice*, from the havock they make among beans when firft fown. They feed alfo on nuts, acorns, and grain, of which they amafs quantities, not proportioned to their wants, but to the capacity of the place where it is depofited, infomuch that a fingle animal will collect more than a bufhel. Thus they provide for other animals as well as themfelves: the hog comes in for a fhare; and the great damage done to the fields by thefe creatures, in rooting up the ground, is chiefly owing to their fearch after the concealed hoards of the field-mice.

The holes of the field-mice are generally more than a foot under ground, and often divided into two apartments, the one for living in with their young, and the other for a magzine. M. Buffon informs us, that he has often feen great damage done to the plantations by thefe animals. They carry off the new-fown acorns; by following the furrow of the plough, they dig up one after another, not leaving a fingle feed. This happens chiefly in thofe feafons when the acorns are fcarce: not finding a fufficient quantity in the woods, they come in queft of them in the cultivated fields, and often carry off fuch quantities that they corrupt in their magazines. Thefe creatures, according to the fame author, do more mifchief in a nurfery of trees than all the birds and other animals put together. The only way to prevent this damage is, to lay traps at ten paces afunder, through the extent of the fown field. No other apparatus is neceffary than a roafted walnut placed under a flat ftone, fupported by a ftick. The animals come to eat the walnut, which they prefer to acorns; and as it is fixed to the ftick, whenever they touch it, the ftone falls down, and crufhes

 crushes them to death. The same expedient M. Buffon also made use of with success against the short-tailed field-mouse, which also destroys acorns. In this way he found that upwards of 100 were taken each day, from a piece of ground consisting only of about 40 French arpents. From the 15th of November to the 8th of December, above 2000 were caught in this manner. Their numbers gradually diminished till the frost became severe, which is the time they retire into their holes, to feed on their magazines. In autumn they are most numerous; for if provisions fail during the winter, they devour one another. The long-tailed mice eat also the short-tailed species; and even thrushes, blackbirds, &c. which they find entangled in snares. They first eat the brain, and then the rest of the body. M. Buffon once kept a dozen of these mice in a cage, and furnished them with food every morning at eight o'clock. One day they were neglected for about a quarter of an hour, when one of their number was eaten up by the rest; next day another suffered the same fate; and in a few days only one remained: all the others had been killed, and partly devoured; and even the survivor himself had his feet and tail mutilated. These animals are very prolific, producing more than once a-year, and bringing nine or ten at a birth. They generally make the nest for their young very near the surface, and often in a thick tuft of grass.

Mr Pennant mentions a species of mouse which he calls the *less long-tailed field-mouse*, or harvest-mouse; and which, he says, is very numerous in Hampshire, particularly during harvest. They form their nest above the ground, between the straws of the standing corn, and sometimes in thistles: it is of a round shape, and composed of the blades of corn. They bring about eight young ones at a time. These never enter houses; but are often carried, in the sheaves of corn, into ricks: and 100 of them have frequently been found in a single rick, on pulling it down to be housed. Those that are not thus carried away in the sheaves, shelter themselves during winter under ground, and burrow deep, forming a warm bed for themselves of dead grass. They are the smallest of the British quadrupeds: the length from nose to tail is only two inches and a half; their tail two inches, and the weight one-sixth of an ounce. They are more slender than the other long-tailed field-mouse; and their back of a fuller red, inclining to the colour of a dormouse.

18. The striatus, or streaked mouse, has four toes on the fore-feet, and five on the hind-ones, longitudinal streaks on the body, with white spots. It is a native of India.

19. The longipes has a long covered tail, four toes on the fore-feet, five on the hind-ones, and very long thighs. It is found in the torrid zone, and is mentioned only by Linnæus.

Plate CLXXXIV fig. 2. 20. The jaculus, or jerboa, inhabits Barbary, Palestine, Egypt, and the deserts between Balsora and Aleppo. The head hath a great resemblance to that of the rabbit; but its eyes are larger, and its ears shorter, higher, and broader, in proportion to its size. The nose is flesh-coloured and naked, and the muzzle is thick and short. The opening of the mouth is very small, the upper jaw broad, and the under jaw narrow and short. The teeth are like those of the rabbit, and the whiskers round the mouth are composed of long black and white hairs. The fore-feet are extremely short, and never touch the ground; being used only as hands to convey victuals to the mouth. These hands have four fingers armed with claws, and the rudiments of a fifth without any claw. The hind-feet have only three toes, the middle one of which is the longest, and all three are armed with claws. The tail is three times longer than the body, and is covered with small stiff hairs, of the same colour with those on the back; and the extremity of it is garnished with longer, softer, and more bushy hair. The legs are naked and flesh-coloured, as well as the nose and ears. The top of the head and back are covered with reddish hair; and the flanks, the under-part of the head, the throat, the belly, and the insides of the thighs, are white. Below the reins, and near the tail, there is a large, black, transverse band, in the form of a crescent. These animals generally conceal their hands or fore-feet among the hair, so that at first sight they seem to have only two feet. In transporting themselves from place to place, they do not walk, or advance one foot before the other, but leap nimbly to the distance of five or six feet from the ground. When reposing themselves, they sit on their knees, and sleep only during the day. They eat grain and herbage like the hare. Their dispositions are mild, and yet they can never be perfectly tamed. They dig holes in the earth like rabbits, and in a much shorter time. Two that were kept in a house in London, burrowed almost through the brick-wall of the room where they were: they came out of their hole at night for food, and when caught were much fatter and sleeker than when confined to their box. This animal is eaten by the Arabs, who call it the *lamb of the children of Israel*. Bochart thinks it is the *Saphon* of holy writ, and displays a vast deal of learning on the subject.

An animal very much resembling the above is found in Siberia, where it is called *alagtaga*. It hath very long transparent ears; long whiskers; five toes on the fore-feet; three on the hind-feet pointing forward, and a fourth behind, about an inch above the heel: the colour of the upper-part of the body is tawny, the lower whitish; in the form of the body, legs, and tail, it agrees with the last. Like the former, this is extremely active; digs holes in the ground with vast agility with its fore-feet; tears the roots with its teeth, and flings back the earth with its hind-feet: if pursued, and finds it cannot escape by leaping, attempts to make a new hole: in some places these are so thick as to be dangerous to travellers, the horses perpetually falling in them. It provides against winter; cuts grass, and leaves it in heaps a foot square to dry, afterwards carrying it into the burrow.

Besides these, M. Buffon describes an animal which probably belongs to the same species, and which he calls the *tarsier*, or woolly jerboa; but says, he accidentally procured it from a person who could neither tell its name, nor from whence it came. It had a sharp-pointed nose; long, erect, naked, transparent ears; large eyes; two cutting teeth in each jaw; and, what is peculiar to this species, two canine teeth in each: it had five long slender fingers on each foot, resembling those of a monkey: the fore-legs moderately long; the hind-legs of a very remarkable length,

length, efpecially the fecond bone; that next the foot flender and naked; the tail exceedingly long and flender; the hair on the body long, foft, and woolly; the head of an afh-colour; the reft of the body tawny, mixed with an afh-colour: it was larger than a common moufe.

21. The volans, has a long hairy tail; four toes on the fore-feet, and five on the hind ones; and the fkin from the ears to the tail is extended like wings, by which means it is enabled to fly. It is a native of Virginia and Mexico.

MUSA, the PLANTAIN-TREE; a genus of the monœcia order, belonging to the polygamia clafs of plants. The moft remarkable fpecies are, 1. The *paradifaica*, or plantain. 2. The *mufa fapientum*, or banana-tree.

The firft fort is cultivated in all the iflands of the Weft Indies, where the fruit ferves the Indians for bread; and fome of the white people alfo prefer it to moft other things, efpecially to the yams and caffada bread. The plant rifes with a foft herbaceous ftalk, 15 or 20 feet high; the lower part of the ftalk is often as large as a man's thigh, diminifhing gradually to the top, where the leaves come out on every fide; thefe are often fix feet long, and near two feet broad, with a ftrong flefhy midrib, and a great number of tranfverfe veins running from the midrib to the borders. The leaves are thin and tender, fo that where they are expofed to the open air, they are generally torn by the wind; for as they are large, the wind has great power againft them: thefe leaves come out from the centre of the ftalk, and are rolled up at their firft appearance; but when they are advanced above the ftalk, they expand and turn backward: as thefe leaves come up rolled in the manner before-mentioned, their advance upward is fo quick, that their growth may almoft be difcerned by the naked eye; and if a fine line is drawn acrofs, level with the top of the leaf, in an hour's time the leaf will be near an inch above it. When the plant is grown to its full height, the fpikes of flowers will appear in the centre, which is often near four feet in length, and nods on one fide. The flowers come out in bunches, thofe in the lower part of the fpike being the largeft, the others diminifh in their fize upward; each of thefe bunches is covered with a fpath or fheath of a fine purple colour, which drops off when the flowers open. The upper part of the fpike is made up of male or barren flowers, which are not fucceeded by fruit, but fall off with their covers. The fruit of this is eight or nine inches long, and above an inch diameter, a little incurved, and has three angles; it is at firft green, but when ripe of a pale-yellow colour. The fkin is tough, and within is a foft pulp of a lufcious fweet flavour. The fpikes of fruit are often fo large as to weigh upwards of 40 lb. The fruit of this fort is generally cut before it is ripe, roafted in the embers, and eaten inftead of bread. The leaves are ufed for napkins and table-cloths, and are food for hogs.

The fecond fort differs from the firft, in having its ftalks marked with dark purple ftripes and fpots. The fruit is fhorter, ftraiter, and rounder: the pulp is fofter, and of a more lufcious tafte; fo is generally eaten by way of defert, and feldom ufed in the fame way as the plantain, therefore is not cultivated in fuch plenty.

Both thefe plants were carried to the Weft Indies from the Canary Iflands, to which place it is believed they were carried from Guinea, where they grow naturally. They are alfo cultivated in Egypt, and in moft other hot countries, where they grow to perfection in about 10 months, from their firft planting to the ripening of their fruit: when their ftalks are cut down, there will feveral fuckers come up from the root, which in fix or eight months will produce fruit; fo that by cutting down the ftalks at different times, there is a conftant fucceffion of fruit all the year.

In Europe there are fome of thefe plants preferved in the gardens of curious perfons, who have hot-houfes capacious enough for their reception, in many of which they have ripened their fruit very well; but as they grow very tall, and their leaves are large, they require more room in the ftove than moft people care to allow them. They are propagated by fuckers, which come from the roots of thofe plants which have fruited; and many times the younger plants, when they are ftinted in growth, will put out fuckers; thefe fhould be carefully taken off, preferving fome fibres to their roots, and planted in pots filled with light rich earth, and plunged into the tan-bed in the ftove: they may be taken off any time in fummer; and it is beft to take them off when young, becaufe if their roots are grown large, they do not put out new fibres fo foon; and when the thick part of the root is cut in taking them off, the plants often rot.

During the fummer-feafon thefe plants muft be plentifully watered; for the furface of their leaves being large, there is a great confumption of moifture by perfpiration in hot weather; but in the winter they muft be watered more fparingly, though at that feafon they muft be often refrefhed, but it muft not be given them in fuch quantities.

The pots in which thefe plants are placed fhould be large, in proportion to the fize of the plants; for their roots generally extend pretty far, and the earth fhould be rich and light. The degree of heat with which thefe plants thrive beft, is much the fame with the anana or pine-apple, in which Mr Miller had many of thefe plants produce their fruit in perfection, and they were near 20 feet high.

The moft fure method to have thefe plants fruit in Britain is, after they have grown fome time in pots, fo as to have made good roots, to fhake them out of the pots with the ball of earth to their roots, and plant them into the tan-bed in the ftove, obferving to lay a little old tan near their roots for their fibres to ftrike into; and in a few months the roots will extend themfelves many feet each way in the bark; and thefe plants will thrive a great deal fafter than thofe which are confined in pots or tubs. When the bark-bed wants to be renewed with frefh tan, there fhould be great care taken of the roots of the plants, not to cut or break them, as alfo to leave a large quantity of the old tan about them; becaufe if the new tan is laid too near them, it will fcorch their roots, and injure them. If the plants pufh out their flower-ftems in the fpring, there will be hopes of their perfecting their fruit; but when they come out late in the year, the plants will fometimes decay before the fruit is ripe. The

ftoves

Mus. ftoves in which they are placed fhould be at leaft 20 feet in height, otherwife there will not be room for their leaves to expand: for when the plants are in vigour, the leaves are often eight feet in length, and near three feet broad; fo that if the ftems grow to be 14 feet to the divifion of the leaves, and the houfe is not 20 feet high, the leaves will be cramped, which will retard the growth of the plant: befides, when the leaves are bent againft the glafs, there will be danger of their breaking them when they are growing vigoroufly; for, in one night, the ftems of fuch bent leaves have been known to force through the glafs, and by the next morning were advanced two or three inches above it.

The fruit of the banana-tree is four or five inches long, of the fize and fhape of a middling cucumber, and of a high, grateful flavour; the leaves are two yards long, and a foot broad in the middle; they join to the top of the body of the tree, and frequently contain in their cavities a great quantity of water, which runs out, upon a fmall incifion being made into the tree, at the junction of the leaves. Bananas grow in great bunches, that weigh a dozen pounds and upwards. The body of the tree is fo porous, as not to merit the name of wood; the tree is only perennial by its roots, and dies down to the ground every autumn.

When the natives of the Weft Indies, fays Labat, undertake a voyage, they make provifion of a pafte of banana; which, in cafe of need, ferves them for nourifhment and drink: for this purpofe, they take ripe bananas, and, having fqueezed them thro' a fine fieve, form the folid fruit into fmall loaves, which are dried in the fun or in hot afhes, after being previoufly wrapped up in the leaves of Indian flowering-reed. When they would make ufe of this pafte, they diffolve it in water, which is very eafily done; and the liquor, thereby rendered thick, has an agreeable acid tafte imparted to it, which makes it both refrefhing and nourifhing.

The banana is greatly efteemed, and even venerated, by the natives of Madeira, who term it the *forbidden fruit*, and reckon it a crime almoft inexpiable to cut it with a knife; becaufe, after diffection, it exhibits, as they pretend, a fimilitude of our Saviour's crucifixion; and to cut the fruit open with a knife, is, in their apprehenfion, to wound his facred image.

Some authors have imagined, that the banana-tree was that of the leaves of which our firft parents made themfelves aprons in Paradife. The facred text, indeed, calls the leaves employed for that purpofe *fig-leaves;* and Milton, in a moft beautiful but erroneous defcription, affirms the bearded or Bengal fig to have been the tree alluded to. But, befides that the fruit of the banana is often by the moft ancients authors called a *fig*, its leaves, by reafon of their great fize and folidity, were much more proper for a veil or covering than thofe of the Bengal fig, which are feldom above fix or eight inches long and three broad. On the other hand, the banana leaves being three, four, and five feet long, and proportionally broad, could not fail to be pitched upon in preference to all others; efpecially as they might be eafily joined, or fewed together, with the numerous thread-like filaments, that may, with the utmoft facility, be peeled from the body of this tree.

Mufæus. MUSÆUS, an ancient Greek poet, was, according to Plato and Diodorus Siculus, an Athenian, the fon of Orpheus, and chief of the Eleufinian myfteries inftituted at Athens in honour of Ceres: or, according to others, he was only the difciple of Orpheus; but, from the great refemblance which there was between his character and talents and thofe of his mafter, by giving a ftronger outline to the figure he was called his *fon*, as thofe were ftyled the *children of Apollo* who cultivated the arts of which he was the tutelar god.

Mufæus is allowed to have been one of the firft poets who verfified the oracles. He is placed in the Arundelian marbles, epoch 15. 1426 B. C. at which time his hymns are there faid to have been received in the celebration of the Eleufinian myfteries. Laertius tells us, that Mufæus not only compofed a theogony, but formed a fphere for the ufe of his companions; yet as this honour is generally given to Chiron, it is more natural to fuppofe, with Sir Ifaac Newton, that he enlarged it with the addition of feveral conftellations after the conqueft of the golden fleece. The fphere itfelf fhews that it was delineated after the Argonautic expedition, which is defcribed in the afterifms, together with feveral other more ancient hiftories of the Greeks, and without any thing later; for the fhip Argo was the firft long veffel which they had built: hitherto they had ufed round fhips of burthen, and kept within fight of the fhore; but now, by the dictates of the oracle, and confent of the princes of Greece, the flower of that country fail rapidly thro' the deep, and guide their fhip by the ftars. Burney's *Hift. of Mufic.*

Mufæus is celebrated by Virgil in the character of hierophant, or prieft of Ceres, at the head of the moft illuftrious mortals who have merited a place in Elyfium. Here he is made the conductor of Æneas to the recefs where he meets the fhade of his father Anchifes.

A hill near the citadel of Athens was called *Mufæum*, according to Paufanias, from Mufæus, who ufed to retire thither to meditate and compofe his religious hymns; at which place he was afterwards buried. The works which went under his name, like thofe of Orpheus, were by many attributed to Onomacritus. Nothing remains of this poet now, nor were any of his writings extant in the time of Paufanias, except a hymn to Ceres, which he made for the Lycomides. And as thefe hymns were likewife fet to mufic, and fung in the myfteries by Mufæus himfelf in the character of prieft, he thence perhaps acquired from future times the title of *mufician* as well as of *poet;* the performance of facred mufic being probably at firft confined to the priefthood in thefe celebrations, as it had been before in Egypt, whence they originated. However, he is not enumerated among ancient muficians by Plutarch; nor does it appear that he merited the title of *fon* and *fucceffor to Orpheus* for his mufical abilities, fo much as for his poetry, piety, and profound knowledge in religious myfteries.

MUSCA, or GNAT, in zoology; a genus of infects, belonging to the order of diptera. The mouth is furnifhed with a flefhy probofcis, and two lateral lips; it has no pappi. There are 129 fpecies, principally diftinguifhed by the peculiarities in their feelers.

MUSCADINE, a rich wine, of the growth of Provence, Languedoc, Cividad, &c.—The word, as well as the liquor, is French: fome fetch its original from *mufk;* the wine being fuppofed to have a little of the fmell of that perfume: others from *mufca*, a "fly," becaufe the flies are extremely fond of its grapes; as the Latins had their *vinum apianum*, fo called *ab apibus*, from the bees which fed on it.

The way of making mufcadine at Frontignac is as follows: They let the mufcadine grapes grow half dry on the vine; as foon as they are gathered, they tread and prefs them immediately, and tun up the liquor, without letting it ftand and work in the fat; the lee occafioning its goodnefs.

MUSCI, MOSSES, one of the feven families or claffes into which all vegetables are divided by Linnæus in the *Philofophia Botanica*. The characteriftics of thefe plants, according to the fexual fyftem, are,

1. Tops, without filaments or threads. 2. The male flower, conftituted by the prefence of the *antheræ* or tops, placed apart from the female, either on the fame or diftinct roots. 3. The female flowers deprived of the *piftillum*, or pointal. 4. The feeds devoid of both lobes (*cotyledones*), and proper coverings; fo that they exhibit the naked embryo.

This tribe of plants, as well as the mufhrooms, ferns, and fea-weed, is ftill imperfectly known. Dillenius, profeffor of botany at Oxford, was the firft who attempted an arrangement of them. In his *Catalogus Plantarum circa Giffam* publifhed at Francfort in 1719, and afterwards in his *Hiftoria Mufcorum* publifhed at Oxford in 1741, he divides the moffes into 16 genera. This arrangement, however, includes the lichens, fome of the fuci, and other plants which belong to very different families. The work in queftion is, notwithftanding, valuable, in having introduced the knowledge of upwards of 200 plants, which were unknown before Dillenius: it is, befides, of all his works of this kind, the beft executed, both for the defcriptions and figures, and fhould ferve as a model to fuch authors as intend to publifh in detail the hiftory of any particular family of plants.

Micheli, in a work intitled *Nova Plantarum Genera*, publifhed at Florence in folio in 1629, divides the moffes into two fections, from the figure and fituation of their flowers. Thefe fections comprehend together 16 genera, amongft which are improperly arranged, like thofe of Dillenius, feveral of the lichens and other fea-weed.

The difcovery of the feeds of the moffes, though made by Dillenius in 1719, is arrogated by Linnæus to himfelf, who did not begin to write till 1735.

In Ray's method, the moffes form the third clafs: in Tournefort's, they conftitute a fingle genus, by the name of *mufcus*, in the firft fection of the 17th clafs, which comprehends the moffes, mufhrooms, and fome of the algæ or fea-weed, and is diftinguifhed by the name of *afpermæ*, or plants without feed; the feeds of the moffes not having been detected by Tournefort.

In the fexual fyftem, thefe plants conftitute the fecond order of the clafs *cryptogamia*, which contains all the plants in which the parts of the flower and fruit are wanting, or not confpicuous. This order is fubdivided into 11 genera, from the prefence or abfence of the calix, which, in thefe plants, is a veil or cover, like a monk's cawl, that is placed over the male organs, or tops of the ftamina, and is denominated *calyptra;* from the fexes of the plants, which bear male and female flowers, fometimes on the fame, fometimes on diftinct roots; and from the manner of growth of the female flowers, which are fometimes produced fingly, fometimes in bunches or cones. Thefe diftinctions are moftly borrowed from Dillenius, whofe excellence in developing this part of the vegetable kingdom Linnæus very readily acknowledges.

MUSCI, is likewife the name of the 56th order in Linnæus's Fragments of a Natural Method. See BOTANY, p. 1317.

MUSCICAPA, or FLY-CATCHER, a genus of birds belonging to the order of pafferes. The moft remarkable fpecies is the grifola, or fpotted fly-catcher. It is a bird of paffage, appears in the fpring, breeds with us, and retires in Auguft. It builds its neft on the fides of trees, towards the middle: Morton fays, in the corners of walls where fpiders weave their webs. Mr Pennant has feen them followed by four or five young, but never faw their eggs. When the young can fly, the old ones withdraw with them into thick woods, where they frolic among the top-branches; dropping from the boughs frequently quite perpendicular on the flies that fport beneath, and rife again in the fame direction. It will alfo take its ftand on the top of fome ftake or poft, from whence it fprings forth on its prey, returning ftill to the fame ftand for many times together. They feed alfo on cherries, of which they feem very fond.

The head is large, of a brownifh hue fpotted obfcurely with black: the back of a moufe-colour: the wings and tail dufky; the interior edges of the quill-feathers edged with pale yellow: the breaft and belly white; the fhafts of the feathers on the former dufky; the throat and fides under the wings are dafhed with red: the bill is very broad at the bafe, is ridged in the middle, and round the bafe are feveral fhort briftles: the infide of the mouth is yellow: the legs and feet are fhort and black.

MUSCLE, in anatomy. See there, p. 363.

MUSCLE, in natural hiftory. See MYTULUS.

MUSEUM, a name which originally fignified a part of the palace of Alexandria, which took up at leaft one-fourth of the city. This quarter was called the *mufeum*, on account of its being fet apart for the mufes and the ftudy of the fciences. Here were lodged and entertained the men of learning; who were divided into many companies or colleges, according to the fciences of which they were the profeffors; and to each of thefe houfes or colleges was allotted a handfome revenue. The foundation of this eftablifhment is attributed to Ptolemy Philadelphus, who here placed his library. Hence the word *mufeum* is now applied to any place fet apart as a repofitory for things that have an immediate relation to the arts.

The mufeum at Oxford, called the *Afhmolean mufeum*, is a noble pile of building, erected at the expence of the univerfity, at the weft end of the theatre, at which fide it has a magnificent portal, fuftained by pillars of the Corinthian order. The front, which is to the ftreet, extends about 60 feet, where there is this infcription over the entrance in gilt characters, *Mufeum Afhmoleanum, fchola naturalis hiftoriæ, officina chymica.*


Fig. 1. Mustela Putorius or Polecat.
B
C
Fig. 2 Mud-Inguina
D
A
E
Fig. 4. Myrmecophaga.
Fig. 3 Mustela Ermina

Mufeum. *chymica.* It was begun in 1679, and finifhed in 1683, when a valuable collection of curiofities was prefented to the univerfity by Elias Afhmole, Efq; which were the fame day repofited there: feveral acceffions have been fince made to the mufeum; among which are hieroglyphics, and other Egyptian antiquities, an entire mummy, Roman antiquities, altars, medals, lamps, &c. and a variety of natural curiofities.

The Britifh mufeum in London is a large, beautiful, and magnificent building, the nobleft cabinet of curiofities in the world. This edifice was erected in 1677; and was called *Montague-houfe*, from having been the town-refidence of the dukes of Montague. In the year 1753, the Britifh parliament, having paffed an act for purchafing the mufeum of the late Sir Hans Sloane, and the collection of manufcripts of the late Lord Oxford, called the *Harleian library*, for the ufe of the public, 26 truftees were appointed and incorporated, to provide a repofitory for thofe and fome other collections, which repofitory was to be called the *Britifh mufeum*. Thefe truftees elected 15 other truftees; and, having bought Montague-houfe, fitted it up for the reception of thefe collections: they alfo appointed officers to fuperintend the mufeum; and having ordained certain ftatutes with refpect to viewing the collection contained in it, the public were admitted to view it in 1757. Among the curiofities contained in the Mufeum are the following:

The library of Sir Hans Sloane, including books of drawings, manufcripts, and prints, in vols	50,000
Medals and coins, ancient and modern	23,000
Cameo's and intaglio's, about	700
Seals	268
Veffels of agate, jafper, &c.	542
Antiquities	1125
Precious ftones, agates, jafpers, &c.	2256
Metals, minerals, ores, &c.	2725
Cryftals, fpars, &c.	1864
Foffils, flints, ftones	1275
Earths, fands, falts	1035
Bitumens, fulphurs, ambers, &c.	399
Talcs, micæ, &c.	388
Corals, fpunges, &c.	1421
Teftacea, &c.	5843
Echini, echinitæ, &c.	659
Afteriæ, trochi, enterochi	241
Cruftaceæ, crabs, lobfters, &c.	363
Stellæ marinæ, ftar-fifhes, &c.	173
Fifhes and their parts	1555
Birds and their parts, eggs, and nefts of different fpecies	1172
Quadrupeds, &c.	1886
Vipers, ferpents, &c.	521
Infects, &c.	5439
Vegetables	12,506
Volumes of dried plants	334
Calculi, anatomical preparations, &c.	756
Mifcellaneous things natural	2098
Mathematical inftruments	55

Fifteen perfons are allowed to view it in one company; the time allotted is two hours; and when any number, not exceeding 15, are inclined to fee it, they muft fend a lift of their Chriftian names and furnames, additions, and places of abode, to the porter's lodge, in order to their being entered in the book: in a few days the refpective tickets will be made out, fpecifying the day and hour when they are to come; which, on being fent for, will be delivered. If by any accident fome of the parties are prevented from coming, it is proper they fend their ticket back to the lodge, as no body can be admitted with it but themfelves. It is to be remarked, that the fewer names there are in a lift, the fooner they are likely to be admitted to fee it.

MUSES, certain fabulous deities among the Pagans, fuppofed to prefide over the arts and fciences: for this reafon it is ufual for the poets, at the beginning of a poem, to invoke thefe goddeffes to their aid. Mufes.

The mufes were originally only fingers and muficians in the fervice of Ofiris, or the great Egyptian Bacchus, under the inftruction and guidance of his fon Orus; but in fucceeding times they were called the *daughters of Jupiter and Mnemofyne* or *Memory*.

Thefe are the only pagan divinities whofe worfhip has been continued through all fucceeding changes in the religion and fentiments of mankind. Profeffors of every liberal art in all the countries of Europe ftill revere them; particularly the poets, who feldom undertake the flighteft work without invoking their aid.

Sir Ifaac Newton tells us, that the finging women of Ofiris were celebrated in Thrace by the name of the *mufes;* and that the daughters of Pierus, a Thracian, imitating them, were celebrated by the fame name.

Diodorus Siculus informs us, that Alcman of Meffene, a lyric poet who flourifhed in the 27th Olympiad, 670 years B. C. makes them the daughters of Uranus and Terra. It has been afferted by fome ancient writers, that at firft they were only three in number; but Homer, Hefiod, and other profound mythologifts, admit of nine (A).

In his hymn to Apollo, Homer fays,

——By turns the *nine* delight to fing.

And Hefiod, in his theogony, names them all. They are faid feverally to prefide over fome art or fcience, as mufic, poetry, dancing, aftronomy. By fome they are called *virgins*, becaufe the virtues of education appear unalterable: they are called *mufes* from a Greek word which fignifies to explain myfteries, becaufe they have taught things the moft curious and important to know, and which are above the comprehenfion of vulgar minds. Each of their names is faid to include fome particular allegory; *Clio*, for inftance, has been thus called, becaufe thofe who are praifed in verfe acquire immortal fame; *Euterpe*, on account of the pleafure accruing to thofe who hear learned poetry; *Thalia* implies for ever flourifhing; *Melpomene*, that her melody infinuates itfelf into the inmoft receffes of the foul; *Terpfichore* marks the plea- Burney's *Hift. of Mufic.*

(A) It has been faid, that when the citizens of Sicyon directed three fkilful ftatuaries to make each of them ftatues of the three Mufes, they were all fo well executed, that they did not know which to choofe, but erected all the nine, and that Hefiod and Homer only gave them names.

pleafure which thofe receive who are verfed in the liberal arts; *Erato* feems to indicate, that the learned command the efteem and friendfhip of all mankind; *Polyhymnia*, that many poets are become immortal by the number of hymns which they have addreffed to the gods; *Urania*, that thofe whom fhe inftructs elevate their contemplations and celebrity to the heavens and the ftars; and laftly, the exquifite voice of *Calliope* has acquired her that appellation, as the inventrefs and guardian of eloquence and rhetoric.

An epigram of Callimachus gives the attributes of the mufes in as many lines.

Calliope the deeds of heroes fings;
Great *Clio* fweeps to hiftory the ftrings;
Euterpe teaches mimes their filent fhow;
Melpomene prefides o'er fcenes of wo;
Terpfichore the flute's foft pow'r difplays;
And *Erato* gives hymns the gods to praife;
Polymnia's fkill infpires melodious ftrains;
Urania wife, the ftarry courfe explains;
And gay *Thalia's* glafs points out where folly reigns.

This epigram does not, however, exactly correfpond with the ideas of other poets, or of the ancient painters, in characterifing the attributes of the mufes. The ancients had numberlefs ingenious and fanciful ideas concerning the mufes. Fulgentius informs us, from the teftimony of various ancient authors, that Apollo was painted with a cithara of *ten ftrings*, as a fymbol of the union of the god with the nine mufes, and to fhew that the human voice is compofed of *ten parts;* of which the four firft are the front-*teeth*, placed one againft the other, fo ufeful for the appulfe of the tongue in forming founds, that, without any one of them, a whiftle would be produced inftead of a voice; the fifth and fixth are the two *lips*, like cymbals, which, by being ftruck againft each other, greatly facilitate fpeech; the feventh is the *tongue*, which ferves as a plectrum to articulate founds; the eighth is the *palate*, the concave of which forms a belly to the inftrument; the ninth is the *throat*, which performs the part of a flute; and the tenth the *lungs*, which fupply the place of bellows.

Pythagoras, and afterwards Plato, make the mufes the foul of the planets in our fyftem; from whence the imaginary mufic of the fpheres.

MUSGRAVE (Dr William), a learned phyfician and antiquary, was born at Charlton-Mufgrave in Somerfetfhire, about the year 1657; and ftudied at New-college, Oxford. Having diftinguifhed himfelf by his knowledge in his profeffion, and his fkill in natural philofophy, he was elected fellow of the Royal Society; and being made fecretary in 1684, he continued the Philofophical Tranfactions from n° 167 to n° 178 inclufive. After having taken his degrees in phyfic, and being admitted a fellow of the college of phyficians, he went and fettled at Exeter, where he practifed phyfic with great reputation and fuccefs. Being a man of extenfive learning, he compofed, at his leifure-hours, feveral curious and valuable works; as, 1. *De arthritide anomala five interna differtatio.* 2. *De arthritide fymptomatica differtatio.* 3. *Julii Vitalis epitaphium, cum commentario.* 4. *De legionibus epiftola.* 5. *De aquilis Romanis epiftola.* 6. *Infcriptio Terraconenfis, cum commentario.* 7. *Geta Britannicus*, &c. 8. *Belgium Britannicum.* This learned phyfician died in 1721.

MUSHROOM, in botany. See AGARICUS and FUNGUS.—Phyficians have difputed much about the qualities of mufhrooms; fome confidering them as a rich nourifhment, and perfectly innocent, when properly chofen; and others afferting them to be extremely deleterious. Moft of the fungi are indeed of a hurtful quality; and, with refpect to the whole tribe, the efculent are very few. Efculent mufhrooms are very nutritive, very readily alkalefcent, and more fo without intermediate acefcency than any other vegetable: they are therefore a rich nourifhment, and much akin to animal-food; on which account they may be indulged in confiderable quantity to ftrong perfons. It requires, however, fkill to diftinguifh this efculent kind; and very few, efpecially of thofe who are commonly employed to gather them, viz. the fervants, have ftudied Clufius, or other authors who have been at the pains to diftinguifh them. Perhaps our efculent mufhrooms, if old, acquire a dangerous acrimony; and for thefe reafons Dr Cullen is of opinion that it is for the moft part prudent to avoid them. In the warmer climates they may be ufed as light food; but here it is prepofterous to ufe them along with animal-food, as they do not correct its alkaline tendency.

M U S I C;

THE art of combining sounds in a manner agreeable to the ear. This combination may be either simultaneous or successive: in the first case, it constitutes harmony; in the last, melody. But though the same sounds, or intervals of sound, which give pleasure when heard in succession, will not always produce the same effect in harmony; yet the principles which constitute the simpler and more perfect kinds of harmony, are almost, if not entirely, the same with those of melody. By *perfect harmony*, we do not here mean that plenitude, those complex modifications of harmonic sound which are admired in practice; but that harmony which is called *perfect* by theoricians and artists; that harmony which results from the coalescence of simultaneous sounds produced by vibrations in the proportions of thirds, fifths, and octaves, or their duplicates.

The principles upon which these various combinations of sound are founded, and by which they are regulated, constitute a science, which is not only extensive but profound, when we would investigate the principles from whence these happy modifications of sound result, and by which they are determined; or when we would explore the sensations, whether mental or corporeal, with which they affect us. The ancient definitions of music are not proportioned in their extent to our present ideas of that art; but M. Rousseau betrays a temerity highly inconsistent with the philosophical character, when from thence he infers, that their ideas were vague and undetermined. Every soul susceptible of refinement and delicacy in taste or sentiment, must be conscious that there is a music in action as well as in sound; and that the ideas of beauty and decorum, of harmony and symmetry, are, if we may use the expression, equally constituent of visible as of audible music. These illustrious minds, whose comprehensive prospects in every science where taste and propriety prevail took in nature at a single glance, would behold with contempt and ridicule those narrow and microscopic views of which alone their successors in philosophy have discovered themselves capacious. With these definitions, however, we are less concerned, as they bear no proportion to the ideas which are now entertained of music. Nor can we follow M. Rousseau, from whatever venerable sources his authority may be derived, in adopting his Egyptian etymology for the word *music*. The established derivation from *Musa* could only be questioned by a paradoxical genius. Is the fact sufficiently authenticated, that music had been practised in Egypt before it was known in Greece? And though it were true, would it follow from thence, that the Greeks had borrowed the name as well as the art from Egypt? If the art of music be so natural to man that vocal melody is practised wherever articulate sounds are used, there can be little reason for deducing the idea of music from the whistling of winds through the reeds that grew on the river Nile. And indeed, when we reflect with how easy a transition we may pass from the accents of speaking to diatonic sounds, when we observe how early children adapt the language of their amusements to measure and melody however rude, when we consider how early and universally these practices take place, there is no avoiding the conclusion, that the idea of music is connatural to man, and implied in the original principles of his constitution. We have already said, that the principles on which it is founded, and the rules by which it is conducted, constitute a science. The same maxims when applied to practice form an art: hence its first and most capital division is into *speculative* and *practical* music.

Speculative music is, if we may be permitted to use the expression, the knowledge of the nature and use of those materials which compose it; or, in other words, of all the different relations between the high and low, between the harsh and the sweet, between the swift and the slow, between the strong and the weak, of which sounds are susceptible; relations which, comprehending all the possible combinations of music and sounds, seem likewise to comprehend all the causes of the impressions which their succession can make upon the ear and upon the soul.

Practical music is the art of applying and reducing to practice those principles which result from the theory of agreeable sounds, whether simultaneous or successive; or, in other words, to conduct and arrange sounds according to the proportions resulting from consonance, from duration and succession, in such a manner as to produce upon the ear the effect which the composer intends. This is the art which we call *composition* *. With respect to the actual production of sounds by voices or instruments, which is called *execution*, this department is merely mechanical and operative; which, only presupposing the powers of sounding the intervals true, of exactly proportioning their degrees of duration, of elevating or depressing sounds according to these gradations which are prescribed by the tone, and to the value required by the time, demands no other knowledge but a familiar acquaintance with the characters used in music, and a habit of expressing them with promptitude and facility.

* See *Composition*.

Speculative music is likewise divided into two departments; *viz.* the knowledge of the proportions of sounds or their intervals, and that of their relative durations; that is to say, of measure and of time.

The first is what among the ancients seems to have been called *harmonical* music. It shews in what the nature of air or melody consists; and discovers what is consonant or discordant, agreeable or disagreeable, in the modulation. It discovers, in a word, the effects which sounds produce in the ear by their nature, by their force, and by their intervals; which is equally applicable to their consonance and their succession.

The second has been called *rhythmical*, because it treats of sounds with regard to their time and quantity. It contains the explication of their continuance, of their proportions, of their measures whether long or short, quick or slow, of the different modes of time and the parts into which they are divided, that to these the succession of sounds may be conformed.

Practical music is likewise divided into two departments,

ments, which correfpond to the two preceding.

That which anfwers to *harmonical* mufic, and which the ancients called *melopée*, teaches the rules for combining and varying the intervals, whether confonant or diffonant, in an agreeable and harmonious manner.

The fecond, which anfwers to the *rhythmical* mufic, and which they called *rhythmopée*, contains the rules for applying the different modes of time, for underftanding the feet by which verfes were fcanned, and the diverfities of meafure; in a word, for the practice of the rhythmus.

Mufic is at prefent divided more fimply into *melody* and *harmony;* for fince the introduction of *harmony* the proportion between the length and fhortnefs of founds, or even that between the diftance of returning cadences, are of lefs confequence amongft us. For it often happens in modern languages, that the verfes affume their meafures from the mufical air, and almoft entirely lofe the fmall fhare of proportion and quantity which in themfelves they poffefs.

By melody the fucceffions of found are regulated in fuch a manner as to produce pleafing airs*.

* See *Melody.*

Harmony confifts in uniting to each of the founds, in a regular fucceffion, two or more different founds, which fimultaneoufly ftriking the ear foothe it by their concurrence. See HARMONY.

Mufic, according to Rouffeau, may be, and perhaps likewife ought to be, divided into the *phyfical* and the *imitative*. The firft is limited to the mere mechanifm of founds, and reaches no further than the external fenfes, without carrying its impreffions to the heart, and can produce nothing but corporeal fenfations more or lefs agreeable. Such is the mufic of fongs, of hymns, of all the airs which only confift in combinations of melodious founds, and in general all mufic which is merely harmonious.

It may, however, be queftioned whether every found, even to the moft fimple, is not either by nature, or by early and confirmed affociation, *imitative*. If we may truft our own feelings, there is no fuch thing in nature as mufic which gives mechanical pleafure alone. For if fo, it muft give fuch pleafure as we receive from taftes, from odours, or from other grateful titillations; but we abfolutely deny that there are any mufical fenfations or pleafures in the fmalleft degree analogous to thofe. Let any piece of mufic be refolved into its elementary parts and their proportions, it will then eafily appear from this analyfis, that fenfe is no more than the vehicle of fuch perceptions, and that mind alone can be fufceptible of them. It may indeed happen, from the number of the performers and the complication of the harmony, that meaning and fentiment may be loft in the multiplicity of founds; but this, though it may be harmony, lofes the name of *mufic*.

The fecond department of his divifion, by lively and accentuated inflections, and by founds which may be faid to fpeak, expreffes all the paffions, paints every poffible picture, reflects every object, fubjects the whole of nature to its fkilful imitations, and impreffes even on the heart and foul of man fentiments proper to affect them in the moft fenfible manner. This, continues he, which is the genuine lyric and theatrical mufic, was what gave double charms and energy to ancient poetry; this is what, in our days, we exert ourfelves in applying to the drama, and what our fingers execute on the ftage. It is in this mufic alone, and not in harmonics or the refonance of nature, that we muft expect to find accounts of thofe prodigious effects which it formerly produced.

But, with Mr Rouffeau's permiffion, all mufic which is not in fome degree characterized by thefe pathetic and imitative powers, deferves no better name than that of a *mufical jargon*, and can only be effectuated by fuch a complication and intricacy of harmony, as may confound, but cannot entertain the audience. This character, therefore, ought to be added as effential to the definition of mufic; and it muft be attributed to our neglect of this alone, whilft our whole attention is beftowed on harmony and execution, that the beft performances of our artifts and compofers are heard with liftlefs indifference and ofcitation, nor ever can conciliate any admirers, but fuch as are induced, by pedantry and affectation, to pretend what they do not feel. Still may the curfe of indifference and inattention purfue and harrow up the fouls of every compofer or performer, who pretends to regale our ears with this mufical legerdemain, till the grin of fcorn, or the hifs of infamy, teach them to correct this depravity of tafte, and entertain us with the voice of nature!

Whilft moral effects are fought in the natural effects of found alone, the fcrutiny will be vain, and difputes will be maintained without being underftood: but founds, as reprefentatives of objects, whether by nature or affociation, introduce new fcenes to the fancy and new feelings to the heart; not from their mechanical powers, but from the connection eftablifhed by the Author of our frame between founds and the objects which either by natural refemblance or unavoidable affociation they are made to reprefent.

It would feem that mufic was one of thofe arts which were firft difcovered; and that vocal was prior to inftrumental mufic, if in the earlieft ages there was any mufic which could be faid to be purely inftrumental. For it is more than probable, that mufic was originally formed to be the vehicle of poetry; and of confequence, though the voice might be fupported and accompanied by inftruments, yet mufic was never intended for inftruments alone.

We are told by ancient authors, that all the laws whether human or divine, exhortations to virtue, the knowledge of the characters and actions of gods and heroes, the lives and atchievements of illuftrious men, were written in verfe, and fung publicly by a quire to the found of inftruments; and it appears from the Scriptures, that fuch from the earlieft times was the cuftom among the Ifraelites. Nor was it poffible to find means more efficacious for impreffing on the mind of man the principles of morals, and infpiring the love of virtue. Perhaps, however, this was not the refult of a premeditated plan; but infpired by fublime fentiments and elevation of thought, which in accents that were fuited and proportioned to their celeftial nature endeavoured to find a language worthy of themfelves and expreffive of their grandeur.

It merits attention, that the ancients were fo fenfible of the value and importance of this divine art, not only as a fymbol of that univerfal order and fymmetry which prevails through the whole frame of material and intelligent nature, but as productive of the moft momentous effects both in moral and political life.

life. Plato and Ariſtotle, who diſagreed almoſt in every other maxim of politics, are unanimous in their approbation of muſic, as an efficacious inſtrument in the formation of the public character and in conducting the ſtate; and it was the general opinion, that whilſt the gymnaſtic exerciſes rendered the conſtitution robuſt and hardy, muſic humanized the character, and ſoftened thoſe habits of roughneſs and ferocity by which men might otherwiſe have degenerated into ſavages. The gradations by which voices were exerted and tuned, by which the invention of one inſtrument ſucceeded to another, or by which the principles of muſic were collected and methodized in ſuch a manner as to give it the form of an art and the dignity of a ſcience, are topics ſo fruitful of conjecture and ſo void of certainty, that we muſt leave them to employ minds more ſpeculative and inventions more prolific than ours, or transfer them to the *Hiſtory* of Muſic as a more proper place for ſuch diſquiſitions. For the amuſement of the curious, Rouſſeau in his *Muſical Dictionary*, Plates C and N, has tranſcribed ſome fragments of Grecian, Perſian, American, Chineſe, and Swiſs muſic, with which performers may entertain themſelves at leiſure. When they have tried the pieces, it is imagined they will be leſs ſanguinely fond than that author of aſcribing the power of muſic to its affinity with the national accents where it is compoſed. This may doubtleſs have its influence; but there are other cauſes more permanent and leſs arbitrary to which it owes its moſt powerful and univerſal charms.

The muſic now moſt generally celebrated and practiſed is that of the Italians, or their ſucceſsful imitations. The Engliſh, from the invaſion of the Saxons, to that more late tho' lucid æra in which they imbibed the art and copied the manner of the Italians, had a muſic which neither pleaſed the ſoul nor charmed the ear. The primitive muſic of the French deſerves no higher panegyric. Of all the barbarous nations, the Scots and Iriſh ſeem to have poſſeſſed the moſt affecting original muſic. The firſt conſiſts of a melody characteriſed by tenderneſs: It melts the ſoul to a pleaſing penſive languor. The other is the native expreſſion of grief and melancholy. Taſſoni informs us, that in his time a prince from Scotland had imported into Italy a lamentable kind of muſic from his own country; and that he himſelf had compoſed pieces in the ſame ſpirit. From this expreſſive, though laconic deſcription, we learn, that the character of our national muſic was even then eſtabliſhed; yet ſo groſs is our ignorance and credulity, that we aſcribe the beſt and moſt impaſſioned airs which are extant among us to David Rizzio; as if an Italian Lutaniſt, who had lived ſo ſhort a time in Scotland, could at once, as it were by inſpiration, have imbibed a ſpirit and compoſed in a manner ſo different from his own. It is yet more ſurpriſing that Geminiani ſhould have entertained and publiſhed the ſame prejudice, upon the miſerable authority of popular tradition alone; for the fact is authenticated by no better credentials. The primitive muſic of the Scots may be divided into the *marchal*, the *paſtoral*, and the *feſtive*. The *firſt* conſiſts either in marches, which were played before the chieftains, in imitation of the battles which they fought, or in lamentations for the cataſtrophes of war and the extinction of families. Theſe wild effuſions of natural melody preſerve ſeveral of the rules preſcribed for compoſition. The ſtrains, though rude and untutored, are frequently terrible or mournful in a very high degree. The part or march is ſometimes in common, ſometimes in treble time; regular in its meaſures, and exact in the diſtance between its returning cadences; moſt frequently, though not always, loud and briſk. The *pibroch*, or imitation of battles, is wild, and abrupt in its tranſitions from interval to interval and from key to key; various and deſultory in its movements; frequently irregular in the return of its cadences; and in ſhort, through the whole, ſeems inſpired with ſuch fury and enthuſiaſm, that the hearer is irreſiſtibly infected with all the rage of precipitate courage, notwithſtanding the rudeneſs of the accents by which it is kindled. To this the *paſtoral* forms a ſtriking contraſt. Its accents are plaintive, yet ſoothing; its harmony generally flat; its modulations natural and agreeable; its rhythmus ſimple and regular; its returning cadences at equal diſtance; its tranſitions from one concinnous interval to another, at leaſt for the moſt part; its movements ſlow, and may be either in common or treble time. It ſcarcely admits of any other harmony than that of a ſimple baſs. A greater number of parts would cover the air, and deſtroy the melody. To this we ſhall add what has been ſaid upon the ſame ſubject by Dr Franklin. Writing to Lord K———, he proceeds thus:

"Give me leave on this occaſion, to extend a little the ſenſe of your poſition, 'That melody and harmony are ſeparately agreeable, and in union delightful;' and to give it as my opinion, that the reaſon why the Scotch tunes have lived ſo long, and will probably live for ever (if they eſcape being ſtifled in modern affected ornament) is merely this, that they are really compoſitions of melody and harmony united, or rather that their melody is harmony. I mean, the ſimple tunes ſung by a ſingle voice. As this will appear paradoxical, I muſt explain my meaning. In common acceptation, indeed, only an agreeable *ſucceſſion* of ſounds is called *melody;* and only the *coexiſtence* of agreeable ſounds, *harmony*. But ſince the memory is capable of retaining for ſome moments a perfect idea of the pitch of a paſt ſound, ſo as to compare it with the pitch of a ſucceeding ſound, and judge truly of their agreement or diſagreement, there may and does ariſe from thence a ſenſe of harmony between the preſent and paſt ſounds, equally pleaſing with that between two preſent ſounds. Now the conſtruction of the old Scotch tunes is this, that almoſt every ſucceeding emphatical note is a third, a fifth, an octave, or in ſhort ſome note that is in concord with the preceding note. Thirds are chiefly uſed, which are very pleaſing concords. I uſe the word *emphatical*, to diſtinguiſh thoſe notes which have a ſtreſs laid on them in ſinging the tune, from the lighter connecting notes that ſerve merely, like grammar-articles in common ſpeech, to tack the whole together.

"That we have a moſt perfect idea of a ſound juſt paſt, I might appeal to all acquainted with muſic, who knows how eaſy it is to repeat a ſound in the ſame pitch with one juſt heard. In tuning an inſtrument, a good ear can as eaſily determine that two ſtrings are in uniſon by ſounding them ſeparately, as by ſounding them together; their diſagreement is alſo as

as eafily, I believe I may fay more eafily and better diftinguifhed when founded feparately; for when founded together, though you know by the beating that one is higher than the other, you cannot tell which it is. I have afcribed to memory the ability of comparing the pitch of a prefent tone with that of one paft. But if there fhould be, as poffibly there may be, fomething in the ear fimilar to what we find in the eye, that ability would not be entirely owing to memory. Poffibly the vibrations given to the auditory nerves by a particular found may actually continue fome time after the caufe of thefe vibrations is paft, and the agreement or difagreement of a fubfequent found become by comparifon with them more difcernible. For the impreffion made on the vifual nerves by a luminous object will continue for 20 or 30 feconds."

After fome experiments to prove the permanancy of vifible impreffions, he continues thus:

"Farther, when we confider by whom thefe ancient tunes were compofed, and how they were firft performed, we fhall fee that fuch harmonical fucceffions of founds was natural and even neceffary in their conftruction. They were compofed by the minftrels of thofe days, to be played on the harp accompanied by the voice. The harp was ftrung with wire, which gives a found of long continuance; and had no contrivance like that of the modern harpfichord, by which the found of the preceding note could be ftopt the moment a fucceeding note begin. To avoid actual difcord, it was therefore neceffary that the fucceeding emphatic note fhould be a cord with the preceding, as their founds muft exift at the fame time. Hence arofe that beauty in thofe tunes that has fo long pleafed, and will pleafe for ever, though men fcarce know why. That they were originally compofed for the harp, and of the moft fimple kind, I mean a harp without any half-notes but thofe in the natural fcale, and with no more than two octaves of ftrings, from C to C, I conjecture from another circumftance; which is, that not one of thefe tunes, really ancient, has a fingle artificial half-note in it; and that in tunes where it is moft convenient for the voice to ufe the middle notes of the harp, and place the key in F, there the B, which if ufed fhould be a B flat, is always omitted, by paffing over it with a third. The connoiffeurs in modern mufic will fay I have no tafte: but I cannot help adding, that I believe our anceftors, in having a good fong, diftinctly articulated, fung to one of thofe tunes, and accompanied by the harp, felt more real pleafure than is communicated by the generality of modern operas, exclufive of that arifing from the fcenery and dancing. Moft tunes of late compofition, not having this natural harmony united with their melody, have recourfe to the artificial harmony of a bafs, and other accompanying parts. This fupport, in my opinion, the old tunes do not need, and are rather confufed than aided by it. Whoever has heard *James Ofwald* play them on his violincello, will be lefs inclined to difpute this with me. I have more than once feen tears of pleafure in the eyes of his auditors; and yet, I think, even *his* playing thofe tunes would pleafe more if he gave them lefs modern ornament."

As thefe obfervations are for the moft part true and always ingenious, we need no other apology for quoting them at length. It is only proper to remark, that the tranfitions in Scots mufic by confonant intervals, does not feem, as Dr Franklin imagines, to arife from the nature of the inftruments upon which they played. It is more than probable, that the ancient Britifh harp was not ftrung with wire, but with the fame materials as the Welfh harps at prefent. Thefe ftrings have not the fame permanency of tone as metal, fo that the found of a preceding emphatic note muft have expired before the fubfequent accented note could be introduced. Befides, they who are acquainted with the manœuvre of the Irifh harp, know well that there is a method of difcontinuing founds no lefs eafy and effectual than upon the harpfichord. When the performer finds it proper to interrupt a note, he has no more to do but return his finger gently upon the ftring immediately ftruck, which effectually ftops its vibration.

That fpecies of Scotch mufic which we have diftinguifhed by the name of *feftive* feems now limited to reels and country-dances. Thefe may be either in common or treble time. They moft frequently confift of two ftrains: each of thefe contains eight or twelve bars. They are truly rhythmical; but the mirth which they excite feems rather to be infpired by the vivacity of the movement, than either by the force or variety of the melody. They have a manœuvre and expreffion peculiar to themfelves, which it is impoffible to defcribe, and which can only be exhibited by good performers.

Thus far we have purfued the general idea of mufic. We fhall, after the hiftory, give a more particular detail of the fcience from Monfieur D'Alembert.

HISTORY OF MUSIC.

1 The uncertainty of facts in mufical hiftory whether ancient or modern.

THE ancient hiftory of mufic, even among the moft cultivated nations, is now either fo entirely loft, or fo unhappily obfcured, that we can make but few certain, and perhaps no fatisfactory difcoveries in it. And as no annals could be tranfmitted to pofterity of that mufic which prevailed among fuch people as are called *barbarous*, our accounts of it muft be ftill lefs authentic and fatisfactory, than thofe of the former. Even at periods which are more recent, and may for that reafon be thought more within the fphere of our inveftigation, we are equally at a lofs both for the æras and the authors of fome effential improvements in mufic. Yet thofe parts of its hiftory, which are either already known, or may be difcovered, if related at full length with proper illuftrations, would produce a work little inferior in fize to the whole extent of that *Encyclopedia* of which it only conftitutes a part. All, therefore, which can be expected from this preliminary account, is to give a fhort and curfory detail of its primary ftate, and its moft important revolutions, fo far as hiftory will enable us, by enlightening our refearches, to accomplifh this defign. But if our accounts are thought concife and imperfect, we fhall all along direct

direct the views of our readers to fources which may prove more copious and more adequate to their curiofity.

2
Opinions concerning the origin of mufic.

It has been pretended by Father Kircher and others, that mufic prevailed in Egypt before it was known in Greece. Thefe authors derive its name from a word which is primitive in the Egyptian language, and attribute the invention of the art to the ftridulous murmur of the winds whiftling through reeds, or other vegetable tubes, which grew upon the banks of the river Nile. But if this idle and legendary account of the difcovery merits any attention at all, it muft relate to inftrumental mufic alone: for it cannot be imagined that mankind, if in the leaft degree attentive to the natural modulation of their own voices, and to fuch tranfitions of found as were agreeable or difagreeable, would have recourfe for their ideas of melody to objects fo extrinfic and fo contingent as the whiftling of winds through a reed. Man is certainly as much a mufical as he is a vocal animal; nor is the act of finging in him lefs inftinctive than in birds, though his powers are more extenfive and more fufceptible of culture than theirs. If we believe the accounts of fuch as have been attentive to the mufic of the groves, they will tell us, that though the feathered warblers have a mufical inftinct, yet the modes of its exertion are as really acquired by birds from their parents or tutors as by men *. Nor is it eafy to conceive a human creature, endowed with the natural powers of mufical fenfation, and advanced to any degree of maturity, without fuppofing at the fame time that he has tried feveral mufical experiments, and that in fome degree he has formed and cultivated his natural organs. At the fame time, it cannot be denied, that the degrees of found, paffing through tubes of different textures, lengths, and diameters, or of ftrings whofe magnitudes and degrees of cohefion were different, muft be afcertained by experiment alone. But whether thefe experiments were the refult of contingency or defign, whether obfervation took the hint from nature, or began of itfelf to make trials and preferve their refults, it feems now too late to determine.

* See the article SINGING of *Birds*.

3
Origin of inftrumental mufic.

The origin of inftrumental mufic appears to have been at a period much prior to the date of authentic hiftory; and when we look for its epoch or its difcoverer, we are carried at once into the wild regions of fable and mythology. The god Mercury, or Hermes, is faid to be the inventor of the lyre *, by diftending ftrings of different tenfions and diameters upon the fhell of a tortoife which he found upon the fhore. The firft exhibition of the fiftula, or fhepherd's pipe, is afcribed to Pan. But of thefe beings and their actions, little or nothing can be afcertained with proper evidence †. We muft therefore content ourfelves with fuch later accounts as merit any degree of confidence.

* Sea the article LYRE.

† See the articles HERMES and MERCURY.

4
The Grecian lyre in its original ftate a fimple inftrument.

The Grecian lyre, in its original ftate, feems to have been an inftrument of the utmoft fimplicity: for, according to fome, the Mercurian lyre confifted only of three, and according to others only of four, ftrings. Thefe being touched open, could only produce the fame number of founds: from whence we may eafily conclude, that the powers of this inftrument could not be very extenfive. This tetrachord, as fome fay, was conjoined; others maintain that it was disjoined, and that its intervals were not even diatonic. It is, however, allowed, that its two extremes produced an octave; and that the two intermediate ftrings divided it by a fourth on each fide, with a tone in the midft, in the following manner:

Ut,———Trite diezeugménon.
Sol,———Lichanos méfon.
Fa,———Parhypate méfon.
Ut,———Parhypate hypaton.

This is what Boëtius calls the tetrachord of Mercury; though Diodorus afferts, that the lyre of Mercury had only three ftrings. This *fyftem* did not long remain confined to fo fmall a number of founds. Chorebus, the fon of Athis king of Lydia, added to it a fifth ftring; Hyagnis, a fixth; Terpander, a feventh, to equal the number of the planets; and at laft, Lychaon of Samos the eighth.

5
The fcale extended.

This is the account of Boëtius. But Pliny fays, that Terpander having added three ftrings to the four which were original, firft played upon the cithara with feven ftrings: that Simonides joined to them an eighth, and Timotheus a ninth. Nicomachus the Gerafenian attributes this eighth chord to Pythagoras, the ninth to Theophraftus of Piereus, afterwards the tenth to Hyfteus of Colophon. Pherecratus, in the dialogue of Plutarch, makes the *fyftem* advance with a more rapid progrefs: he gives twelve ftrings to the cythara of Menalippides, and as many to that of Timotheus. And as Pherecratus was contemporary with thefe muficians, if we fuppofe that he really faid what Plutarch attributes to him, his teftimony will have confiderable importance in a fact which was obvious to his own immediate obfervation.

6
Ancient authors on mufic irreconcileable.

But how fhall we obtain any certainty among fuch a number of contradictions as are found not only in the doctrines of the authors, but in the order of the events which they relate? For inftance, the tetrachord of Mercury evidently gives the octave or diapafon. How then could it happen, that, after the addition of three ftrings, the whole fcale was found to be diminifhed by one degree, and reduced to the interval of a feventh? This is, however, what the greateft number of authors leave us to underftand; and among others Nicomachus, who tells us, that Pythagoras, finding the whole *fyftem* compofed only of two conjoined tetrachords, which between their extremes formed a diffonant interval, rendered it a confonance, by dividing thefe two tetrachords by the interval of a tone, which produced the octave.

Whatever be the cafe, there is at leaft one thing certain, that the fyftem of the Greeks was infenfibly extended as well above as below, till it reached, and even furpaffed, the compafs of a difdiapafon or double octave; a feries which they call a *perfect fyftem*, and which was likewife termed the *greateft* and the *moft unchangeable*; becaufe, between its two extremes, which betwixt themfelves formed a perfect confonance, were contained all the fimple, the double, the direct, or the inverted chords, every particular fyftem, and according to them the greateft intervals, which can take place in melody.

7
The nature of the perfect fyftem.

This whole *fyftem* confifted of four tetrachords, three conjoined and one disjoined; and of a fingle note redundant, which was added below the whole to complete the double octave; from whence the ftring which

which formed it took the name of *proſlambanomene*, or the additional ſtring. This, one would imagine, could only form fifteen notes in the diatonick genus; there were, however, ſixteen. This was becauſe the diſjunction being ſometimes perceived between the ſecond and third tetrachord, and at other times between the third and fourth, it happened, in the firſt caſe, that the ſound *la* or A, the higheſt in the ſecond tetrachord, the *ſi* or B natural, with which the third tetrachord began, immediately followed in aſcending; or otherwiſe, in the ſecond caſe, that the ſame ſound *la*, with which note itſelf the third tetrachord begun, was immediately followed by *ſi* or B flat; for the firſt gradation of every tetrachord, in the diatonick ſpecies, conſiſted always of a ſemitone. This difference then produced a ſixteenth ſound, on account of the *ſi* or B, which was natural or flat according to its various poſitions in the different tetrachords. The ſixteen ſounds were expreſſed by eighteen different names; that is to ſay, that *ut* or C, and *re* or D, being either the ſharpeſt or the middle ſounds of the third tetrachord, according to the two manners of disjoining the tetrachords, they gave to each of theſe two ſounds a name which determined its poſition.

But as the fundamental ſound was varied according to the mode, from the ſituation occupied by each mode in the general ſyſtem aroſe a difference of acuteneſs and gravity, which very much multiplied the ſounds: for though the different modes had many ſounds in common, there were likewiſe ſome peculiar to each mode, or to ſome of them alone. Thus, in the diatonick genus alone, the extent of all the ſounds admitted in the fifteen modes enumerated by Aliphius amounted to three octaves; and as the difference between the fundamental ſound of each mode and that of its contiguous ſound was a ſemitone only, it is evident, that all that ſpace divided by ſemitones produced, in the general ſcale, the quantity of thirty-four ſounds practiſed in ancient muſic; which, if we deduct all the replicates of the ſame ſound, and confine ourſelves to the limits of an octave, it will be found to be chromatically diviſible into twelve different ſounds, as in modern muſic. This is obvious from the table placed by Meibomius at the front of Aliphius's work. Theſe remarks are neceſſary to refute the error of thoſe who believe, upon the credit of ſome moderns, that the whole of ancient muſic was limited to ſixteen ſounds.

In Rouſſeau's Muſical Dictionary, Plate H, fig. 12. will be found a table of the general ſyſtem amongſt the Greeks, taken in one mode only, and according to the diatonic genus. With reſpect to the enharmonic and chromatic genera, the tetrachords were divided by very different proportions; but as they always contained four ſounds and three conſecutive intervals, in the ſame manner as the diatonic genus, each of theſe ſounds, in its particular genus, bore the ſame names which correſponded with them in the diatonic. For this reaſon Rouſſeau, whom we follow, has not given particular tables for each of theſe genera. The curious may conſult thoſe of Meibomius, placed at the front of the work of Ariſtoxenus. They will there find ſix; one for the enharmonic genus, three for the chromatic, and two for the diatonic, according to the ſituations of each of theſe genera in the ſyſtem of Ariſtoxenus.

Such, in its perfection, was the general ſyſtem of the Greeks; which remained almoſt in the ſame ſtate till the eleventh century, the time when Guy d'Arezzo made conſiderable changes in it. He added below a new ſtring, which he called *hypoproſlambanomene*, or "ſub-added," and above a fifth tetrachord. Beſides this, he invented, as they ſay, a flat, to diſtinguiſh the ſecond ſound of a conjunctive tetrachord from the firſt of the ſame tetrachord when disjunctive; that is to ſay, he fixed the double ſignification of the letter B, which St Gregory before him had already given to the note *ſi* or B. For ſince it is certain that the Greeks had for a long time theſe very conjunctions and disjunctions of the tetrachord, and of conſequence ſigns for expreſſing each degree in theſe different caſes, it follows, that this was not a new ſound introduced into the ſyſtem of Guido, but merely a new name which he gave to that ſound; thus reducing to one degree what, among the Greeks, had conſtituted two. It muſt likewiſe be obſerved concerning his hexachords, which were ſubſtituted for their tetrachords, that it was leſs a change of ſyſtem than of method; and that all which reſulted from it was another manner of ſolfa'ing the ſame ſounds. But the *character* of Guido, and the alterations which he made in the ancient ſcale, may be more properly reſumed when we reach the period in which he lived. 8 The Grecian ſcale changed that whic is now in uſe by G do Aretin

We have already ſeen from Rouſſeau, that the different accounts of the ſyſtem and its improvements, of the different kinds of muſic, and of the modes to be met with among ancient harmoniſts, are ſo various and ſo obſcure, that, in theſe diſquiſitions, little or no ſatisfaction can be obtained. For aſcertaining with accuracy the diverſity of intervals, Pythagoras, the philoſopher of Samos, invented the monochord, or the different diviſions of one ſingle ſtring by which the conſonances were produced, and found the ſame ratios which are given in the ſubſequent elements of muſic, in Malcolm's account of the ſcale, and in ſeveral other authors unneceſſary to be enumerated. For a fuller and more exact account of this monochord, and its uſe, ſee the Hiſtory of Muſic by Sir John Hawkins, Vol. I. p. 449. where the neceſſity of applying it to practice is inculcated by Guido. 9 The invention and uſe of the monochord

Had ſucceeding writers upon the ſcience been more attentive to the real conſtitution of the ſcale, and the principles derived from a monochord properly divided, we might have expected their account of the other phænomena in muſic to have been more preciſe and more perſpicuous; but for a conſiderable time after that philoſopher, the accounts of ancient muſic tranſmitted to us are either ſuperficial and curſory, or unintelligible. The modes, of which Aliphius reckoned fifteen, are by Ptolemy limited to ſeven. Even of the ſeven Ptolemaic modes, it would ſeem that five muſt be merely poſſible and nominal; two only real and practical. Theſe appear to coincide with the major and minor mode of the moderns, by which effects ſimilar to thoſe aſcribed to the ancient modes are produced. Still, however, this hypotheſis is attended with ſome difficulty: The effects attributed to the modes of the moderns ſeem to be no more than cheerfulneſs and melancholy; whereas it would appear that different ſentiments were thought to be naturally excited by all the different modes of the ancients, ſuch as courage and terror, fury and complacency, &c. Yet 10 Diverſity of opinions concerning modes.

Yet if by ancient modes we are to underſtand any given intervals which predominate in a piece of muſic, it is far from being eaſy to conceive any other explication which will ſo rationally account for the modes of Ptolemy, as that which we have immediately before recited. A more particular detail of this author, of Boetius, and of Ariſtides Quintilianus, than it is in our power to give, circumſcribed as we are by limits much too narrow for ſuch an undertaking, will be found in Sir John Hawkins's Hiſtory of Muſic, Vol. I. Theſe are ſome of the chief writers whoſe works remain to us, and have eſcaped the depredations of time. Moſt of the other ancient writers upon muſic either appear to have been loſt, or only to have treated the ſubject occaſionally. Among theſe may be reckoned Vitruvius, author of a treatiſe on architecture, who, in his deſcription of theatres, takes the opportunity of propoſing ſome muſical improvements, of making ſome caſual obſervations upon the art, and of deſcribing an hydraulic organ. But as a more particular account of theſe would throw no additional light upon the theory of ancient muſic, for this we muſt once more remit the curious to *Meibomius de re Muſica*, and to the hiſtory by Sir John Hawkins above quoted.

The province to which our efforts are neceſſarily confined, directs our attention not ſo much to the hiſtory of thoſe who cultivated the art, as to the art itſelf, and its various revolutions.

The diſcovery of the monochord and its diviſions, was not the only ſpeculation in muſic peculiar to Pythagoras. He likewiſe thought the earth and ſeven planets, or ſolar ſyſtem, reſembled a muſical diapaſon; and from thence formed the romantic idea of the muſic of the ſpheres. For a more ſatisfactory account of this celeſtial concert, the curious reader may peruſe the *Somnium Scipionis*, a fragment of Cicero, and the *Obſervations upon numbers* by his commentator Macrobius.

Pythagoras, the philoſopher of Samos, as we have ſaid above, who taught in Italy, was the firſt who inveſtigated the relations of ſound by meaſuring a muſical ſtring, and obſerving the tones produced by the vibrations of its different parts, whilſt the others were at reſt. Theſe he expreſſed by numbers, and thus aſcertained the ratio which one ſound bears to another. This inveſtigation was afterwards carried farther, and delineated more diſtinctly, by Euclid; and gave riſe to a controverſy which divided the theoretical writers on ancient muſic into two principal ſects, viz. the followers of Pythagoras, who maintained that intervals could only be aſcertained by the vibrations of ſonorous bodies compared one with another; and thoſe of Ariſtoxenus, who aſſerted the judgment of the ear to be the ultimate criterion of intervals. Perhaps neither were abſolutely right, nor entirely wrong. Without aſcertaining by experiments and calculations the diſtances of tones, or quantities of intervals, we can by no means obtain the ſame certainty of their exactitude, whether in tuning inſtruments of fixed ſcales, or in performing upon thoſe whoſe notes admit of variation, and where the temperament is immediate and occaſional. So far the Pythagoreans are right. Yet the Ariſtoxenians might likewiſe urge, that, though we could ſuppoſe a being acquainted with all the properties, relations, and modes of quantity, in their full extent; if ſuch a one, with all this knowledge, ſhould attempt from mere theory to compoſe a piece of good muſic, he might be eternally engaged in the ſame employment to no purpoſe, and have the mortification to ſee himſelf every inſtant outdone by a mere mechanical performer, who had been long inured to judge of intervals, and practiſed in the laws of harmony. In ſhort, the whole powers of geometry and algebra may be exhauſted, without producing a muſical ſtrain which will give real pleaſure to the ear. An adept, therefore, in this delightful art, will regulate his practice by his theory, and confirm his theory by his practice. He will not imagine the neceſſity of experiment and calculation ſuperſeded by the deciſion of his ear; nor will he endeavour to extort from the abſtract nature of numbers (which are equally applicable to all ſubjects that contain quantity) thoſe rules which taſte and ſenſation alone can ſuggeſt, and of which they are the ultimate ſtandard.

11 The application of numbers to muſical intervals divide muſicians into different ſects.

12 The principles of theſe ſects eſtimated.

Nicomachus the Geraſenian lived A. C. 60, and wrote a book called *Introduction to harmony*, which ſeems to be one of the cleareſt and moſt intelligible of the Greeks.

In the *Sympoſiaca* of Plutarch is a dialogue on muſic, containing many anecdotes with reſpect to the invention of ſeveral different ſpecies of muſic and poetry. There Phrynis and Timotheus are recorded to have been ſtigmatized for adding what were eſteemed ſupernumerary ſtrings to the lyre, which at that time had only ſeven, to mark the different degrees of the diapaſon. But the additional ſtrings were tuned by intervals leſs than diatonic. This dialogue, however, is acknowledged to be obſcure, and its authenticity queſtioned.

13 The forms and powers of ancient inſtruments.

After exploring what can be known concerning the ancient muſic, from the theories and writings of thoſe whoſe works have been tranſmitted to us, the forms and powers of their inſtruments occur next to be examined. Theſe can only be collected from verbal deſcriptions, or from deſigns either expreſſed in colours or by ſculpture. From theſe, modern muſicians have not ſcrupled to form a moſt contemptible idea of practical muſic among the ancients. But are we ſure, that the deſcriptions are perfectly complete and thoroughly underſtood? If they were, does there not ſtill remain a poſſibility, that they might be tuned and handled in a manner productive of effects to which we are ſtrangers? Of our inſtruments now in uſe, the difference between one manner of performing and another is ſo aſtoniſhing, that one ſhould imagine it might render us cautious in forming any concluſions concerning inſtruments, which are perhaps neither perfectly deſcribed nor exactly delineated, deſcribed by authors of a period ſufficiently diſtant to render the idioms of the language in which they wrote obſcure. And tho' the forms exhibited in colours or by ſculpture may be thought more permanent and more univerſally intelligible, they are yet ſufficiently ſubjected to the injuries of time to render their repreſentations ſuſpicious.

14 The power of ancient muſic, tho' exaggerated in fable, muſt have been great to give theſe fables credit.

It cannot be doubted, but that the accounts of the ancients, of the power and efficacy of their muſic, were frequently fabulous and hyperbolical; but ſtill they are ſuch as, when diveſted of theſe accidental circumſtances, muſt convince any man of common ſenſe, who admits the

the evidence of history, that they are superior to what we at present experience in music with all its boasted improvements. It may well be admitted, that the miracles ascribed to Orpheus and Amphion are false in their literal sense; but no person will imagine, that, even among the superstitious and illiterate vulgar, fables of this kind could have obtained any degree of attention, or been entertained with any other sentiments than those of ridicule, if the truths which they adumbrated had not been uncommonly striking. Nor would it have been relished as a tolerable legend, that music had the power of animating stones and trees, if its visible effects upon sensitive beings at that period had not been wonderfully transporting. It is therefore a degree of incredulity which does no great honour to the authority of modern testimony, to doubt the assertion of Horace, when he tells us, that, by the force of music, the human savage was allured from his acorns, his brutal pastimes, and his sanguine broils, to the more decent habits and amiable employments of

15 The music of barbarous nations covered with obscurity.

social life. It has been formerly observed, that among such nations as were esteemed barbarous, we meet with no accounts either of music or its instruments which either deserve credit or attention. It is not easy to conceive how the Jews, who had made such a great progress in arts and civilization, should still have remained so backward in their musical acquisitions, as they must have been if we take for granted the figures and powers of their instruments, as delineated by Kircher, and transcribed by Sir John Hawkins. Nor will the advantages which are generally allowed to the instruments of other barbarous nations, afford a satisfactory account how they were able either to compose or perform such pieces of music as we know them to have possessed. We must therefore with good reason suspect, that the authors of such descriptions have either been grossly ignorant of the subject, or shamefully careless and remiss in the performance of their task.

Almost in every period since the restitution of literature, an important controversy has been agitated by virtuosi of different opinions in the theory of music.

16 Harmony, whether known to the ancients or not, uncertain.

Some have maintained that harmony was, and others that it was not, known to the ancients. By some of these it was contended, that the knowledge of harmony naturally results from the knowledge of consonances; that by tuning their instruments the ancients must have been familiar to the various coalescences of sound, and that of consequence they could not be ignorant of the pleasure which they produce. Several passages likewise from such dissertations or fragments as have escaped the rage of time, are collected to prove that the ancients must have been acquainted with harmony or symphonical music.

The opponents of this hypothesis have alleged, that from the sensations or ideas of simple chords no conception could be formed of the effects produced by their conjunction or succession. It is on all hands agreed, that several voices and instruments were used by the Greeks and Romans in performing the same piece of music; but the antiharmonists, as we may term them, will not admit that the intervals of these voices or instruments were varied: nay, it is affirmed that they performed always in octave or unison one to the other; and from thence it is pretended, that all the passages which seem to import the acquaintance of the ancients with practical harmony may be rationally and consistently explained. This, however, notwithstanding the labours of French critics, will still remain extremely doubtful to any person who has either perused the dialogue above mentioned as ascribed to Plutarch, or other passages to the same purpose. 17

Origin and author of harmony doubtful.

Nor can it be reasonably thought, that, at a period so barbarous as the 12th century, harmony, though rude and simple, should have been the creature of naked invention in places where every other branch of literature and degree of culture were unknown. Yet it is clear from the monkish historians of that æra, that harmony was even then in practice, where it could hardly be supposed to be immediately transmitted by a progress so rapid from other parts of the world, where the finer organization of the natives, the more propitious aspect of nature, and the more obvious vestiges of ancient improvement, might be thought favourable to the invention, culture, and propagation of the fine arts. Nor is it a weak presumption, in favour of the knowledge of antiquity in harmony, that the adherence of a contrary opinion can neither ascertain the epoch nor the parent of symphonic music. Yet had it been, as they pretend, a modern invention, barbarous and ignorant as the general character of human nature was during that gloomy interval from the decline of the Roman empire to the resuscitation of letters, the author of an improvement so new and extraordinary could not have escaped the public notice. His name, his character, and his discoveries, must have been recorded by the cloistered authors of his time with 18

This an argument for the antiquity of harmony.

panegyric and admiration. We cannot therefore cease to think with the author of *The principles and power of harmony*, p. 133. that the ancients were better acquainted with this species of music than the moderns are willing to allow; though perhaps it may be admitted, that its powers were neither so thoroughly known, nor so generally and successfully practised, as afterwards. 19

Revival of music.

After the long and cruel devastation of the Goths and Vandals, music seems first to have been revived for the service of the church. It was then of two different kinds, one of which was called the *Ambrosian* and the other the *Gregorian* chant. Of these, the last prevailed, and became universal, till corrupted by the ignorance or false taste of its teachers and performers. This degeneracy became at last the subject of high remonstrance and complaint. It seems to have consisted in a total negligence of rhythmus, and in a perversion of that licence of gracing the notes, which is so essential to all emphatic and animated music. It became, however, so contagious and diffusive, that monarchs thought the rescue of the *Cantus Gregorianus* an object worthy of their interposition. They accordingly authorised more profound adepts and more accurate performers to teach and practise it in its purity through their several dominions. The *antiphonaries*, or books of ecclesiastical music, were rectified, and a more correct and legitimate taste re-established. Thus the *Cantus Gregorianus* once more triumphed over ignorance and barbarity, and obtained a reception worthy of its original sublimity. It is denominated among the French, and by Rousseau in particular, *plain chant*. That author scruples not to reckon it

it a precious remain of antiquity. For a ſhort account of the nature and revolutions of this muſic, may be conſulted the article *Plain Chant* in his Muſical Dictionary. From whence it appears, that the Gregorian muſic was not originally different from the Ambroſian, but the latter only an improvement upon the former. One would be tempted to ſuſpect, that the firſt gradation of this muſic towards its decline was occaſioned by transferring it from verſe to proſe. In conſequence of which, that ſtrict and inviolable regard to meaſured ſounds, ſo conſpicuous in ancient muſic, and ſo effectually preſerved by the aptitude of meaſured notes to meaſured ſyllables, was loſt. There is, we know, even in proſaic compoſitions, a rhythmus. The Roman orators were accuſtomed to ſcan their ſentences in proſe. But though even periods of this kind were by no means emancipated from the laws of rhythmus, yet were they much more looſe and indefinite than poetical numbers, which were conſtituted by feet and ſyllables whoſe quantities were determined. From thence, and from the cadences by which they are marked, alone, can reſult that regularity and ſatisfaction in which the muſical ear acquieſces, and without which every thing is unintelligible. It was this religious obſervation of determined and regular quantities in ancient poetry, which preſerved and regulated the due proportion of ſounds, and which, when abandoned, left the value of notes, with reſpect to their duration, impoſſible to be determined, till other characters and ſigns were ſuperadded, which diſcovered the

20 Inventions of characters to expreſs the rhythmus.

real eſtimate of every note, and ſhowed to what degree it ſhould be protracted, or by what quantity of duration limited. This ſeems to have been the next advance in muſical improvement; but it had one pernicious effect, which was, to render muſic independent of poetry. Yet theſe ſiſter-arts ſeem to be twin-born from heaven; and perhaps, in no caſe could the laws of nature have ſuffered a more cruel and impious violation than in ſeparating the one from the other.

21 Affinity between muſic and poetry.

Modulated ſound is a more genuine, powerful, and univerſal vehicle of ſentiment, than any articulate or arbitrary ſigns can poſſibly be. But articulate ſigns may be ſo happily adjuſted by convention, as to expreſs degrees, varieties, and modes of ſentiment or emotion, which in modulated ſounds are leſs definitely ſignified, if ſignified at all. Thus ſounds give energy and ſweetneſs to word, words variety and definiteneſs to ſounds.

We have already obſerved, that Guy d'Arezzio, otherwiſe named *Guido Aretinus* †, was the inventor of that diſpoſition of the muſical ſcale which is now in uſe. He could not, therefore, be the author of harmony, which we know to have been practiſed ſome centuries before his time, but only of a new ſet of characters by which it was expreſſed. This muſician, by changing the tetrachords into hexachords, highly improved the ſcale, diſcovered more accurately the poſition of ſemitones, and rendered its intonation much more practicable. He likewiſe adapted the ſyllables *ut*, *re*, *mi*, *fa*, *ſol*, *la*, to the various ſounds which compoſe it, from the following Sapphic verſes in a hymn to St John.

† See the article ARETIN.

UT queant laxis *REſonare fibris*
MIra geſtorum *FAmuli tuorum*
SOLve polluti *LAbii reatum.*
SANCTE JOANNES.

The rhythmus in muſic, or the regular diviſion and meaſures of ſound, had formerly been determined by the quantities of the feet in poetry; and, independent of theſe, ſeems to have been entirely indefinite. The invention of a rhythmus capable of ſubſiſting by itſelf, is aſcribed to one *Johannes de Muris*. Yet there is conſiderable reaſon to believe that it had been invented by one *Franco*, who lived a number of years before him.

22 Diviſion of muſic into eccleſiaſtical and ſecular.

In theſe times there was a ſecular as well as ſacred muſic. The Troubadours, or Provençal poets, compoſed ſongs of different kinds, which they ſung to their harps or violins for public entertainment. Hence it happened, that harmony, melody, and rhythmus, admitted of immenſely greater varieties than they had hitherto done. We have formerly ſaid, that in ancient muſic, the quantities or values of every note were determined by thoſe of the ſyllables to which they anſwered. It is, however, by no means improbable, that at a very early period, in their private rehearſals, or practice for improvement, whether in taſte or execution, the muſicians frequently played the inſtrumental parts without being accompanied either by the voice or the words to which they had been ſet. The impreſſions of thoſe poetical meaſures to which the parts correſponded, were abundantly ſufficient to preſerve in the memory of the performer the idea of the rhythmus, and of courſe to determine the value of each particular note. But when airs were either ſet to pieces in proſe, or compoſed without any regard to ſyllabical duration, the quantity of each note was abſolutely indefinite.

23 Origin of the term counterpoint.

When therefore muſic begun to be ſet in parts, it was indiſpenſably neceſſary that the points which mark the notes intended to correſpond one with another, ſhould be ſet in direct oppoſition. Hence the denomination of *counterpoint*. But when characters, or different forms of characters, were invented for expreſſing the different durations of ſounds, or their relative proportions one to another, the ſame preciſion in oppoſing note to note became leſs neceſſary, and was on that account leſs ſcrupulouſly obſerved. It might, perhaps, be neither an unpleaſing nor uninſtructive deduction, after having delineated the nature of ſimple counterpoint, to trace it thro' all its different ſpecies or diviſions; but the contracted ſphere in which we are at preſent conſtrained to move, obliges us to confine theſe excurſions. Such readers as may wiſh more profoundly and minutely to examine this matter, will find it more perſpicuouſly and fully explained in Sir John Hawkins's Hiſtory. To this they may likewiſe recur for an idea of the characters or methods by which the preciſe duration of particular notes might be aſcertained. For us, it ſuffices to add, that the method now in practice, which are explained in the following elements, will be found more ſimple, whilſt at the ſame time, it is equally expreſſive and intelligible.

24 Diviſion of ſecular muſic.

The airs into which ſecular muſic was originally diſtinguiſhed ſeem to have been the madrigal, the ſong, the cantata, the canon. Theſe were vocal, or at leaſt common to voices and inſtruments; but the ſolo, the phantaſia, the concerto, were progreſſive changes in inſtrumental muſic. By what gradations they proceeded, and who were the inventors of each particular ſpecies, we cannot attempt to ſhow, not only becauſe ſuch a diſquiſition would be incompatible with

the limits of our plan, but becauſe we ſhould find it frequently impracticable either to inveſtigate the hints from which ſuch innovations aroſe, or the perſons by whom they were made.

25 Revival of dramatic muſic.

If muſic be allowed to poſſeſs imitative powers, it will follow, that in proportion as the objects are intereſting, the imitation muſt likewiſe engage and command attention. From this, it will be acknowledged, that as imitation is the chief purpoſe of dramatic muſic; as the actions, characters, and ſituations exhibited in the drama, are the moſt intereſting that can poſſibly be diſplayed; and as the dramatic is allowed to be the moſt perfect of all poſſible imitations; ſo of all muſic, the dramatic, in its perfection, ought to be the moſt powerful and enchanting. It is therefore a reſearch of no ſmall importance, to diſcover when this kind of muſic was firſt revived, and by what degrees it arrived at its preſent ſtate.

It is generally agreed, that the Greeks and Romans ſung their tragedies and comedies from beginning to end; but no monument of theſe compoſitions remains to us: ſo that the muſic of the drama is as really a modern invention as if no ſuch thing had ſubſiſted among the ancients, ſince the mere knowledge of a fact could by no means throw any light upon the manner in which it was produced. All that has been tranſmitted to us concerning the ancient theatrical muſic, can only inform us, that it was pathetic and imitative to a high degree. But upon theſe hints few compoſers will think themſelves ſufficiently inſtructed to proceed. This arduous enterpriſe, however, was nobly begun and ſucceſsfully proſecuted by one *Jacapo Peri*. A poet, whoſe name was *Ottavio Rinuccino* in the city of Florence, having compoſed a dramatic paſtoral upon the ſtory of Apollo and Daphne, engaged this excellent muſician to ſet it. Both being warmed with the ſame ideas, and animated by the ſame deſign, ſo happily ſucceeded, that other poets and muſicians were generally approved and admired in proportion as they purſued the veſtiges of theſe great maſters. A ſecond performance of the ſame kind, called *Eurydice*, compoſed by the authors of the former paſtoral, was repreſented in Florence in the year 1600, upon occaſion of the marriage of Mary de Medicis with Henry IV of France. But a detail of the gradations by which theatrical muſic roſe to its preſent perfection, would be a taſk too extenſive for the limits by which we are circumſcribed. Nor is it in our power, for the ſame reaſon, to enter more minutely and critically into the nature of thoſe compoſitions called *operas*. Let it ſuffice to add, that, in common with tragedy and comedy, they are repreſentations of action. In conſequence of this, they require the ſame unity of deſign, the ſame diverſity of characters and paſſions, with the former. Hence it follows, that ſome parts of them will be ſimply narrative, ſome pathetic, and others more emphatically deſcriptive. Muſic ſuited to the firſt of theſe is called *recitativo*. Its diſtinguiſhing characteriſtics are, to expreſs the nature and degree of ſentiment exhibited by the ſpeaker, to be ſcrupulouſly adapted to the peculiar genius of that language which it is deſigned to accompany; and to be exactly modelled according to the accents of that nation, for which it was formed. Some authors have pretended that the irreſiſtible efficacy of melody was founded upon this principle alone. But if that poſition be true, in what manner ſhall we account for the wonderful influence of an Italian recitativo upon a Britiſh audience, and for other phænomena of the ſame kind too numerous to be mentioned? Such parts of the muſic as are intended for more pathetic declamations may be called *airs*. In theſe the words, both with reſpect to their quantity and order, may be treated with greater freedom. The melody is leſs in the tone of converſation, and the harmony more complex. In this, however, there is no ſmall hazard leſt ſentiment ſhould be loſt in ſound; and it requires no ſmall degree of judgment, delicacy, and taſte in the compoſer, at once to fill the harmony and preſerve the ſentiment. But of this the reader will find a more complete account under the article Air in this Dictionary. The chorus is intended to expreſs ſome emphatic event, to celebrate ſome diſtinguiſhed hero, or to praiſe ſome beneficent god. It is properly the voice of triumph and exultation. The harmony ſhould therefore be as full and expreſſive as poſſible. But for the rules of ſuch compoſitions, one muſt refer the reader to ſuch theoretical and practical muſicians as have been moſt ſucceſsful in deſcribing and cultivating dramatic muſic. What remains for us is to ſubjoin a liſt of thoſe who have been moſt remarkable for their accuracy in the theory, or for their excellence in the practice, of muſic in general.

26 Delineation of the opera.

27 Catalogue of theatrical and practical muſicians.

Of John de Muris we have already ſpoken, who lived in the year 1330, and to whom, by miſtake, has been attributed the invention of thoſe characters by which, in modern times, the value of notes, and their relative proportions one to another, have been aſcertained. But this expedient for making viſible the different durations of notes as conſtituent of one rhythmus or particular movement, we have found to be firſt introduced by one Franco, who lived prior to John de Muris.

Laſus was the firſt who wrote on muſic; but his work is loſt, as well as ſeveral other books of the Greeks and Romans upon the ſame ſubject. Ariſtoxenus, the diſciple of Ariſtotle, and leader of a ſect in muſic, is the moſt ancient author who remains to us upon this ſcience. After him came Euclid of Alexandria. Ariſtidis Quintilianus wrote after Cicero. Alyphus afterwards ſucceeded; then Guadentius, Nicomachus, and Bacchius.

Marcus Meibomius has favoured us with a beautiful edition of theſe ſeven Greek authors, with a Latin tranſlation and notes.

Plutarch, as has already been ſaid, wrote a dialogue upon *muſic*. Ptolemy, a celebrated mathematician, wrote in Greek a treatiſe intitled *The Principles of Harmony*, about the time of the emperor Antoninus. This author endeavoured to preſerve a medium between the Pythagoreans and the Ariſtoxenians. A long time afterwards, Manuel Pryennius wrote likewiſe upon the ſame ſubject.

Among the Latins, Boetius wrote in the times of Theodoric; and not diſtant from the ſame period Martianus, Caſſiodorus, and St Auguſtine.

The number of the moderns is almoſt indefinite. The moſt diſtinguiſhed are, Zarlino, Salinas *, Valgulio, Galileo, Doni, Kircher, Merſenne, Parran, Perault, Wallis, Deſcartes, Holden, Mengoli, Malcolm, Baretti, Vallotti, Marcus Meibomius, Chriſtopher Simpſon; Tartini, whoſe book is full of deep reſearches and

* See the article Blind.

and of genius, but tedious from its prodigious length, and perplexed with obſcurity; and M. Rameau, whoſe writings have had this ſingular good luck, to have produced a great fortune without being read almoſt by any one. Beſides, the world may now be ſpared the pains of peruſing them, ſince M. d'Alembert has taken the trouble of explaining to the public the ſyſtem of the fundamental baſs, the only uſeful and intelligible diſcovery which we find in Rameau's writings. To theſe we may add Dr Smith, author of a learned and mathematical treatiſe, intitled, *Harmonics*, or *The Philoſophy of muſical Sounds*; Mr Stillingfleet, author of the *Principles and the Power of Harmony*, or *An explication of Tartini's ſyſtem*; Dr Pepuſch, and his noble pupil the Lord Abercorn; Mr Aviſon, late organiſt at Newcaſtle, who wrote a treatiſe on *Muſical Expreſſion* with the politeneſs and elegance of a gentleman, the depth and preciſion of a ſcholar, the ſpirit and energy of a genius. The names of Rouſſeau and d'Alembert have been ſo often repeated during the courſe of theſe muſical lucubrations, that it would be ſuperfluous to reſume their characters in this place. Among the authors already mentioned, it would be unpardonable to omit the names of Sir John Hawkins and Dr Burney, each of whom has favoured the world with a hiſtory of muſic: The firſt protracted to five volumes in quarto, replete with muſical erudition, but ſeldom original; frequently careleſs, and ſometimes too circumſtantial and inelegant to be entertaining. Of the laſt the world has only as yet ſeen one volume. This abounds with deſcriptions, events, and diſquiſitions, highly worthy of attention: but, on account of the limits which the author has preſcribed to himſelf, many things have been omitted which would have been equally acceptable to literary curioſity, and explicative of muſical ſcience.

ELEMENTS OF MUSIC,

THEORETICAL and PRACTICAL (†).

PRELIMINARY DISCOURSE.

28 Muſicians conſidered in a double view.

MUSIC may be conſidered, either as an art, which has for its object one of the greateſt pleaſures of which our ſenſes (‡) are ſuſceptible; or as a ſcience, by which that art is reduced to principles. This is the double view in which we mean to treat of muſic in this work.

29 Progreſs of muſic like that of other arts and ſciences.

It has been the caſe with muſic as with all the other arts invented by men: ſome facts were at firſt diſcovered by accident; ſoon afterwards reflection and obſervation inveſtigated others; and from theſe facts, properly diſpoſed and united, philoſophers were not ſlow in forming a body of ſcience, which afterwards increaſed by degrees.

The firſt theories of muſic were perhaps as ancient as the earlieſt age which we know to have been diſtinguiſhed by philoſphy, even as the age of Pythagoras; nor does hiſtory leave us any room to doubt, that from the period when that philoſopher taught, the ancients cultivated muſic, both as an art and as a ſcience, with great aſſiduity. But there remains to us much uncertainty concerning the degree of perfection to which they brought it. Almoſt every queſtion which has been propoſed with reſpect to the muſic of the ancients has divided the learned; and may probably ſtill continue to divide them, for want of monuments ſufficient in their number, and inconteſtable in their nature, from whence we might be enabled to exhibit teſtimonies and diſcoveries inſtead of ſuppoſitions and conjectures. As we cannot throw any new light upon this ſubject, all that can be done is to refer our readers to the different authors who have treated of ancient muſic. It were to be wiſhed, that, in order to elucidate as much as

30 The hiſtory of muſic a deſideratum in literature.

(†) To deliver the elementary principles of muſic, theoretical and practical, in a manner which may prove at once entertaining and inſtructive, without protracting this article much beyond the limits preſcribed in our plan, appears to us no eaſy taſk. We therefore heſitated for ſome time, whether to try our own ſtrength, or to follow ſome eminent author on the ſame ſubject. Of theſe the laſt ſeemed preferable. Amongſt theſe authors, none appeared to us ſo eligible as the treatiſe of M. D'Alembert, being the moſt methodical, perſpicuous, conciſe, and elegant diſſertation which we have met with. As this work is hitherto unknown to Engliſh readers, it ought to have all the merit of an original. We have given a faithful tranſlation of it; but in the notes, ſeveral remarks are added, and many authors quoted, which will not be found in the original. It is a work ſo ſyſtematically compoſed, that all attempts to abridge it, without rendering it obſcure and imperfect, would be impracticable. It is perhaps impoſſible to render the ſyſtem of muſic intelligible in a work of leſs compaſs than that with which our readers are now preſented; and, in our judgment, a performance of this kind, which is written in ſuch a manner as not to be generally underſtood, were much better ſuppreſſed.

(‡) In this paſſage, and in the definitions of melody and harmony, our author ſeems to have adopted the vulgar error, that the pleaſure of muſic terminates in corporeal ſenſe. He would have pronounced it abſurd to aſſert the ſame thing of painting. Yet if the former be no more than a mere pleaſure of corporeal ſenſe, the latter muſt likewiſe be ranked in the ſame predicament. We acknowledge that corporeal ſenſe is the vehicle of ſound; but it is plain from our immediate feelings, that the reſults of ſound arranged according to the principles of melody, or combined and diſpoſed according to the laws of harmony, are the objects of a reflex or internal ſenſe.

For a more ſatisfactory diſcuſſion of this matter, the reader may conſult that elegant and judicious treatiſe on Muſical Expreſſion by Mr Aviſon. In the mean time it may be neceſſary to add, that, in order to ſhun the appearance of affectation, we ſhall uſe the ordinary terms by which muſical ſenſations, or the mediums by which they are conveyed, are generally denominated.

as poſſible, a point ſo momentous in the hiſtory of the ſciences, ſome perſon of learning, equally ſkilled in the Greek language and in muſic, ſhould exert himſelf to unite and diſcuſs in the ſame work the moſt probable opinions eſtabliſhed or propoſed by the learned upon a ſubject ſo difficult and curious. This philoſophical hiſtory of ancient muſic is a work which might highly embelliſh the literature of our times.

In the mean time, till an author can be found, ſufficiently inſtructed in the arts and in hiſtory, to undertake ſuch a labour with ſucceſs, we ſhall content ourſelves with conſidering the preſent ſtate of muſic, and limit our endeavours to the explication of thoſe acceſſions which have accrued to the theory of muſic in theſe latter times.

There are two departments in muſic, melody * and harmony †. Melody is the art of arranging ſeveral ſounds in ſucceſſion one to another in a manner agreeable to the ear; harmony is the art of pleaſing that organ by the union of ſeveral ſounds which are heard at one and the ſame time. Melody has been known and felt through all ages: perhaps the ſame cannot be affirmed of harmony (§), we know not whether the ancients made any uſe of it or not, nor at what period it began to be practiſed.

* See *Melody*.
† See *Harmony*.

Not but that the ancients certainly employed in their muſic thoſe chords which were moſt perfect and ſimple; ſuch as the octave, the fifth, and the third: but it ſeems doubtful, whether they knew any of the other conſonances or not, or even whether in practice they could deduce the ſame advantages from the ſimple chords which were known to them, that have afterwards accrued from experience and combinations.

If that harmony which we now practiſe owes its origin to the experience and reflection of the moderns, there is the higheſt probability, that the firſt eſſays of this art, as of all the others, were feeble, and the progreſs of its efforts almoſt imperceptible; and that, in the courſe of time, improving by ſmall gradations, the ſucceſſive labours of ſeveral geniuſes have elevated it to that degree of perfection in which at preſent we find it.

31
The origin of arts often accidental, and their progreſs gradual.

The firſt inventor of harmony eſcapes our inveſtigation, from the ſame cauſes which leave us ignorant of thoſe who firſt invented each particular ſcience; becauſe the original inventors could only advance one ſtep, a ſucceeding diſcoverer afterwards made a more ſenſible improvement, and the firſt imperfect eſſays in every kind were loſt in the more extenſive and ſtriking views to which they led. Thus the arts which we now enjoy, are for the moſt part far from being due to any particular man, or to any nation excluſively: they are produced by the united and ſucceſſive endeavours of mankind; they are the reſults of ſuch continued and united reflections, as have been formed by all men at all periods and in all nations.

It might, however, be wiſhed, that after having aſcertained, with as much accuracy as poſſible, the ſtate of ancient muſic by the ſmall number of Greek authors which remain to us, the ſame application were immediately directed to inveſtigate the firſt inconteſtable traces of harmony which appear in the ſucceeding ages, and to purſue theſe traces from period to deriod. The products of theſe reſearches would doubtleſs be very imperfect, becauſe the books and monuments of the middle ages are by far too few to enlighten that gloomy and barbarous æra; yet theſe diſcoveries would ſtill be precious to a philoſopher, who delights to obſerve the human mind in the gradual evolutions of its powers, and the progreſs of its attainments.

32
Delineations of the laws of harmony recent and imperfect.

The firſt compoſitions upon the laws of harmony which we know, are of no higher antiquity than two ages prior to our own; and they were followed by many others. But none of theſe eſſays was capable of ſatiſfying the mind concerning the principles of harmony: they confined themſelves almoſt entirely to the ſingle occupation of collecting rules, without endeavouring to account for them; neither had their analogies one with another, nor their common ſource, been perceived; a blind and unenlightened experience was the only compaſs by which the artiſt could direct and regulate his courſe.

33
Its precepts not deduced from any principle till by M. Rameau.

M. Rameau was the firſt who began to transfuſe light and order through this chaos. In the different tones produced by the ſame ſonorous body, he found the moſt probable origin of harmony, and the cauſe of that pleaſure which we receive from it. His principle he unfolded, and ſhewed how the different phænomena of muſic were produced by it: he reduced all the conſonances to a ſmall number of ſimple and fundamental chords, of which the others are only combinations or various arrangements. He has, in ſhort, been able to diſcover, and render ſenſible to others, the mutual dependence between melody and harmony.

34
The author's motives for writing theſe elements.

Though theſe different topics may be contained in the writings of this celebrated artiſt, and in theſe writings may be underſtood by philoſophers who are likewiſe adepts in the art of muſic; ſtill, however, ſuch muſicians as were not philoſphers, and ſuch philoſophers as were not muſicians, have long deſired to ſee theſe objects brought more within the reach of their capacity: ſuch is the intention of the treatiſe I now preſent to the public. I had formerly compoſed it for the uſe of ſome friends. As the work appeared to them clear and methodical, they have engaged me to publiſh it, perſuaded (though perhaps with too much credulity), that it might be uſeful to facilitate the progreſs of initiates in the ſtudy of harmony.

This was the only motive which could have determined me to publiſh a book of which I might without

(§) Though no certainty can be obtained what the ancients underſtood of harmony, nor in what manner and in what period they practiſed it; yet it is not without probability, that, both in ſpeculation and practice, they were in poſſeſſion of what we denominate *counterpoint*. Without ſuppoſing this, there are ſome paſſages in the Greek authors which can admit of no ſatisfactory interpretation. See the *Origin and Progreſs of Language*, Vol. II. Beſides, we can diſcover ſome veſtiges of harmony, however rude and imperfect, in the hiſtory of the Gothic ages, and amongſt the moſt barbarous people. This they could not have derived from more cultivated countries, becauſe it appears to be incorporated with their national muſic. The moſt rational account, therefore, which can be given, ſeems to be, that it was conveyed in a mechanical or traditionary manner through the Roman provinces from a more remote period of antiquity.

Prelim. Diſcourſe.

out heſitation aſſume the honour, if its materials had been the fruits of my own invention, but in which I can now boaſt no other merit than that of having developed, elucidated, and perhaps in ſome reſpects improved, the ideas of another (c).

35 Improvements of this edition.

The firſt edition of this eſſay, publiſhed 1752, having been favourably received by the world, and copies no longer to be found in the hands of bookſellers, I have endeavoured to render this more perfect.

35 Account of the work in general.

The detail which I mean to give of my labour, will preſent the reader with a general idea of the principle of M. Rameau, of the conſequences deduced from it, of the manner in which I have diſpoſed this principle and its conſequences; in ſhort, of what is ſtill a-wanting, and might be advantageous to the theory of this amiable art; of what ſtill remains for the learned to contribute towards the perfection of this theory; of the rocks and quickſands which they ought to avoid in this reſearch, and which could ſerve no other purpoſe than to retard their progreſs.

36 Rameau's origin of harmony.

Every ſonorous body, beſides its principal ſound, likewiſe exhibits to the ear the 12th and 17th major of that ſound. This multiplicity of different, yet concordant ſounds, known for a conſiderable time, conſtitutes the baſis of the whole theory of M. Rameau, and the foundation upon which he builds the whole ſuperſtructure of a muſical ſyſtem *. In theſe our *elements* may be ſeen, how from this experiment one may deduce, by an eaſy operation of reaſon, the chief points of melody and harmony; the perfect † chord, as well major as minor; the two ‡ tetrachords employed in ancient muſic; the formation of our diatonic ‖ ſcale; the different values § which the ſame ſound may have in that ſcale, according to the turn which is given to the baſs *; the alterations ¶ which we obſerve in that ſcale, and the reaſon why they are totally imperceptible to the ear; the rules peculiar to the mode † major; the difficulty in ‡ intonation of forming three tones ‖ in ſucceſſion; the reaſon why two perfect chords are proſcribed in immediate ſucceſſion in the diatonic order; the origin of the minor mode, its ſubordination to the mode major, and its variations; the uſe of diſcord §; the cauſes of ſuch effects as are produced by different kinds of muſic, whether diatonic, chromatic *, or enharmonic †; the principles and laws of temperament ‡. In this diſcourſe we can only point out thoſe different objects, the ſubſequent eſſay being deſigned to explain them with the minuteneſs and preciſion which they require.

* See *Syſtem.* † See *Chord.* ‡ See *Tetrachord.* ‖ See *Diatonic.* § See *Value.* * See *Baſs.* ¶ See *Alteration.* † See *Mode.* ‡ See *Intonation.* ‖ See *Tone.* § See *Diſcord.* * See *Chromatic.* † See *Enharmonic.* ‡ See *Temperament.*

One end which we have propoſed in this treatiſe, was not only to place the diſcoveries of M. Rameau in their moſt conſpicuous and advantageous light, but even in particular reſpects to render them more ſimple. For inſtance, beſides the fundamental experiment which we have mentioned above, that celebrated muſician, to render the explication of ſome particular phænomena in muſic more acceſſible, had recourſe to another experiment; I mean that which ſhows that a ſonorous body ſtruck and put in vibration, forces its 12th and 17th major in deſcending to divide themſelves and produce a tremulous ſound. The chief uſe which M. Rameau made of this ſecond experiment was to inveſtigate the origin of the minor mode, and to give a ſatisfactory account of ſome other rules eſtabliſhed in harmony; and with reſpect to this in our firſt edition we have implicitly followed him: in this we have found means to deduce from the firſt experiment alone the formation of the minor mode, and beſides to diſengage that formation from all the queſtions which were foreign to it.

It is the ſame caſe with ſome other points (as the origin of the chord of the ſub-dominant §, and the explication of the ſeventh in ſome peculiar reſpects), upon which it is imagined that we have ſimplified, and perhaps in ſome meaſure extended, the principles of the celebrated artiſt.

§ See *Subdominant.*

We have likewiſe baniſhed from this edition, as from the former, every conſideration of geometrical, arithmetical, and harmonical proportions and progreſſions, which authors have endeavoured to find in the mixture and protraction of tones produced by a ſonorous body; perſuaded as we are, that M. Rameau was under no neceſſity of paying the leaſt regard to theſe proportions, which we believe to be not only uſeleſs, but even, if we may venture to ſay ſo, fallacious when applied to the theory of muſic. In ſhort, though the relations produced by the octave, the fifth, and the third, &c. were quite different from what they are; though in theſe chords we ſhould neither remark any progreſſion nor any law; though they ſhould be incommenſurable one with another; the protracted tone of a ſonorous body, and the multiplied ſounds which reſult from it, are a ſufficient foundation for the whole harmonic ſyſtem.

37 Theoretical muſicians cautioned with regard to the admiſſion of mathematical or metaphyſical principles in muſic.

But though this work is intended to explain the theory of muſic, and to reduce it to a ſyſtem more complete and more luminous than has hitherto been done, we ought to caution thoſe who ſhall read this treatiſe, that they may be careful not to deceive themſelves, either by miſapprehending the nature of our object, or the end which our endeavours purſue.

We muſt not here look for that ſtriking evidence which is peculiar to geometrical diſcoveries alone, and which can be ſo rarely obtained in theſe mixed diſquiſitions, where natural philoſophy is likewiſe concerned: into the theory of muſical phænomena there muſt always enter a particular kind of metaphyſics, which theſe phænomena implicitly take for granted, and which brings along with it its natural obſcurity. In this ſubject, therefore, it would be abſurd to expect what is called *demonſtration*: it is an atchievement of no ſmall importance, to have reduced the principal facts to a ſyſtem conſiſtent with itſelf, and firmly connected in its parts; to have deduced them from one ſimple experiment; and to have eſtabliſhed upon this foundation the moſt common and eſſential rules of the muſical art. But in another view, if here it be improper to require that intimate and unalterable conviction which can only be produced by the ſtrongeſt evidence, we remain in the mean time doubtful whether it is poſſible to elucidate this ſubject more ſtrongly.

After this declaration, one ſhould not be aſtoniſhed, that, amongſt the facts which are deduced from our fundamental experiment, there ſhould be ſome which appear immediately to depend upon that experiment, and others which are deduced from it in a way more remote

(c) See M. Rameau's letter upon this ſubject, *Merc. de Mai* 1752.

Prelim. Discourse.

remote and less direct. In disquisitions of natural philosophy, where we are scarcely allowed to use any other arguments, except such as arise from analogy or congruity, it is natural that the analogy should be sometimes more sometimes less sensible: and we will venture to assert, that such a mind must be very improper for philosophy, which cannot recognise and distinguish this gradation and the different circumstances on which it proceeds. It is not even surprising, that in a subject where analogy alone can take place, this conductress should desert us all at once in our attempts to account for certain phænomena. This likewise happens in the suject which we now treat; nor do we conceal the fact, however mortifying, that there are certain points (though there number be but small) which appear still in some degree unaccountable from our principle. Such, for instance, is the procedure of the diatonic scale in descending; the formation of the chord commonly termed the *sixth redundant* * or *superfluous*, and some other facts of less importance, for which as yet we can scarcely offer any satisfactory account except from experience alone.

* See *Redundant*.

Thus, though the greatest number of the phænomena in the art of music appear to be deducible in a simple and easy manner from the protracted tone of sonorous bodies, one ought not perhaps with too much temerity to affirm as yet, that this mixed and protracted tone is *demonstratively* the only original principle of harmony (D). But in the mean time it would not be less unjust to reject this principle, because certain phænomena appear to be deduced from it with less success than others. It is only necessary to conclude from this, either that by future scrutinies means may be found for reducing these phænomena to this principle; or that harmony has perhaps some other unknown principle, more general than that which results from the protracted and compounded tone of sonorous bodies, and of which this is only a branch; or lastly, that we ought not perhaps to attempt the reduction of the whole science of music to one and the same principle;

38 Rameau's primary experiment has not as yet accounted for all the phænomena of music. Perhaps some other may be necessary.

which, however, is the natural effect of an impatience so frequent even among philosophers themselves, which induces them to take a part for the whole, and to judge of objects in their full extent by the greatest number of their appearances.

In those sciences which are called *physico-mathematical*, (and amongst this number perhaps the science of sounds may be placed), there are some phænomena which depend only upon one single principle, and one single experiment: there are others which necessarily suppose a greater number both of experiments and principles, whose combination is indispensable in forming an exact and complete system; and music perhaps is in this last case. It is for this reason, that, whilst we bestow on M. Rameau all due praise, we should not at the same time neglect to stimulate the learned in their endeavours to carry them still to higher degrees of perfection, by adding if it is possible such improvements as may be wanting to consummate the science.

Whatever the result of their efforts may be, the reputation of this intelligent artist has nothing to fear: he will still have the advantage of being the first who rendered music a science worthy of philosophical attention; to have made its practice more simple and easy; and to have taught musicians to employ in this subject the light of reason and analogy.

We would the more willingly persuade those who are skilled in theory and eminent in practice to extend and improve the views of him who before them pursued and pointed out the career, because many amongst them have already made laudable attempts, and have even been in some measure successful in diffusing new light through the theory of this enchanting art. It was with this view that the celebrated Tartini has presented us in 1754 with a treatise of harmony, founded on a principle different from that of M. Rameau. This principle is the result of a most beautiful experiment (†). If at once two different sounds are produced from two instruments of the same kind, these two sounds

39 Tartini's experiment.

(D) The *demonstration* of the principles of harmony by M. Rameau was not thus entitled in the exposition which he presented in the year 1749 to the Academy of Sciences, and which that society besides approved with all the eulogiums which the author deserved; the title, as inserted in the register of the academy, was, "A memorial, in which are explained the foundations of a system of music theoretical and practical." It is likewise under this title that it was announced and approved of by the Commissioners, who in their printed report, which the public may read along with M. Rameau's memorial, have never dignified his theory with any other name than that of a *system*, the only name in reality which is expressive of its nature. M. Rameau, who, after the approbation of the academy, has thought himself at liberty to adorn his system with the name of a *demonstration*, did not certainly recollect what the academy has frequently declared; that, in approving any work, it was by no means implied that the principles of that work appeared to them demonstrated. In short, M. Rameau himself, in some writings posterior to what he calls his *demonstration*, acknowledges, that upon particular points in the theory of the musical art, he is under a necessity of having recourse to analogy and aptitude; this excludes every idea of demonstration, and restores the theory of the musical art, exhibited by M. Rameau, to the class in which it can only be ranked with propriety, I mean the class of probabilities.

(†) Had the utility of the preliminary discourse in which we are now engaged been less important and obvious than it really is, we should not have given ourselves the trouble of translating, nor our readers that of perusing it. But it must be evident to every one, that the cautions here given, and the advices offered, are no less applicable to students than to authors The first question here decided, is, Whether pure mathematics can be successfully applied to the theory of music. The author is justly of a contrary opinion. It may certainly be doubted with great justice, whether the solid contents of sonorous bodies, and their degrees of cohesion or elasticity, can be ascertained with sufficient accuracy to render them the subjects of musical speculation, and to determine their effects with such precision as may render the conclusions deduced from them geometrically

Prelim. Discourse.

founds generate * a third different from both the others. They have inserted in the *Encyclopédie*, under the article *Fundamental*, a detail of this experiment according to M. Tartini; and we owe to the public an information of which in composing this article we were ignorant: M. Rameau, a member of the Royal Society at Montpellier, had presented to that society in the year 1753, before the work of M. Tartini had appeared, a memorial printed the same year, and where may be found the same experiment displayed at full length. In relating this fact, which it was necessary for us to do, it is by no means our intention to detract in any degree from the reputation of M. Tartini; we are persuaded that he owes this discovery to his own researches alone: but we think ourselves obliged in honour to give a public testimony in favour of him who was the first in exhibiting this discovery.

See Generate.

40 [Thi]s discovery originally due [t]o Rameau.

But whatever be the case, it is in this experiment that M. Tartini attempts to find the origin of harmony: his book, however, is written in a manner so obscure, that it is impossible for us to form any judgment of it; and we are told that others distinguished for their knowledge of the science are of the same opinion. It were to be wished that the author would engage some man of letters, equally practised in music and skilled in the art of writing, to unfold these ideas which he has not discovered with sufficient perspicuity, and from whence the art might perhaps derive considerable advantage if they were placed in a proper light. Of this I am so much the more persuaded, that even though this experiment should not be regarded by others in the same view with M. Tartini as the foundation of the musical art, it is nevertheless extremely probable that one might use it with the greatest advantage to enlighten and facilitate the practice of harmony (E).

In exhorting philosophers and artists to make new attempts for the advancement of the theory of music, we ought at the same time to let them know the danger of mistaking what is the real end of their researches. Experience is the only foundation upon which they can proceed; it is alone by the observation of facts, by bringing them together in one view, by shewing their dependency upon one, if possible, or at least upon a very small number of primary facts, that they can reach the end to which they so ardently aspire, the important end of establishing an exact theory of music, where nothing is wanting, nothing obscure, but every thing discovered in its full extent, and in its proper light. The philosopher who is properly enlightened, will not give himself the trouble to explain such facts as are less essential to his art, because he can discern those on which he ought to expatiate for its proper illustration. If one would estimate them according to their proper value, he will only find it necessary to cast his eyes upon the attempts of natural philosophers who have discovered the greatest skill in their science; to explain, for instance, the multiplicity of tones produced by sonorous bodies. These sages, after having remarked (what is by no means difficult to conclude) that the universal vibration of a musical string is a mixture of several partial vibrations, from thence infer, that a sonorous body ought to produce a multiplicity of tones, as it really does. But why should this multiplied sound only appear to contain three, and why these three preferable to others? Some pretend that there are particles in the air, which, by their different degrees of magnitude and texture, being naturally susceptible of different oscillations, produce the multiplicity of sound in

41 Mechanical conclusions inadequate to the situation of musical phænomena.

cally true. It is admitted, that sound is a secondary quality of matter, and that secondary qualities have no obvious connection which we can trace with the sensations produced by them. Experience, therefore, and not speculation, is the grand criterion of musical phænomena. For the effects of geometry in illustrating the theory of music, (if any will still be so credulous as to pay them much attention), the English reader may consult Smith's Harmonics, Malcom's dissertation on music, and Pleydel's treatise on the same subject inserted in a former edition of this work. Our author next treats of the famous discovery made by Sig. Tartini, of which the reader may accept the following compendious account.

If two sounds be produced at the same time properly tuned and with due force, from their conjunction a third sound is generated, so much more distinctly to be perceived by delicate ears as the relation between the generating sounds is more simple; yet from this rule we must except the unison and octave. From the fifth is produced a sound unison with its lowest generator; from the fourth, one which is an octave lower than the highest of its generators; from the third major, one which is an octave lower than its lowest; and from the sixth minor (whose highest note forms an octave with the lowest in the third formerly mentioned) will be produced a sound lower by a double octave than the highest of the lesser sixth; from the third minor, one which is double the distance of a greater third from its lowest; but from the sixth major (whose highest note makes an octave to the lowest in the third minor), will be produced a sound only lower by double the quantity of a greater third, than the highest; from the second major, a sound lower by a double octave than the lowest; from a second minor, a sound lower by triple the quantity of a third major than the highest; from the interval of a diatonic or greater semitone, a sound lower by a triple octave than the highest; from that of a minor or chromatic semitone, a sound lower by the quantity of a fifth four times multiplied than the lowest, &c. &c. But that these musical phænomena may be tried by experiments proper to ascertain them, two hautboys tuned with scrupulous exactness must be procured, whilst the musicians are placed at the distance of some paces one from the other, and the hearers in the middle. The violin will likewise give the same chords, but they will be less distinctly perceived, and the experiment more fallacious, because the vibrations of other strings may be supposed to enter into it.

If our English reader should be curious to examine these experiments and the deductions made from them in the theory of music, he will find them clearly explained and illustrated in a treatise called *Principles and power of harmony*, printed at London in the year 1771.

(E) See the article FUNDAMENTAL in the French *Encyclopédie*, vol. vii. p. 63.

in queftion. But what do we know of all this hypothetical doctrine? And though it fhould even be granted, that there is fuch a diverfity of tenfion in thefe aërial particles, how fhould this diverfity prevent them from being all of them confounded in their vibrations by the motions of a fonorous body? What then fhould be the refult, when the vibrations arrive at our ears, but a confufed and inappretiable ‡ noife, where one could not diftinguifh any particular found? (F)

‡ See *Inappretiable.*

41
Metaphyfical conclufions lefs adequate.

If philofophical muficians ought not to lofe their time in fearching for mechanical explications of the phænomena in mufic, explications which will always be found vague and unfatisfactory; much lefs is it their province to exhauft their powers in vain attempts to rife above their fphere into a region ftill more remote from the profpect of their faculties, and to lofe themfelves in a labyrinth of metaphyfical fpeculations upon the caufes of that pleafure which we feel from harmony. In vain would they accumulate hypothefis on hypothefis, to find a reafon why fome chords fhould pleafe us more than others. The futility of thefe fuppofititious accounts muft be obvious to every one who has the leaft penetration. Let us judge of the reft by the moft probable which has till now been invented for that purpofe. Some afcribe the different degrees of pleafure which we feel from chords, to the more or lefs frequent coincidence of vibrations; others to the relations which thefe vibrations have among themfelves as they are more or lefs fimple. But why fhould this coincidence of vibrations, that is to fay, their fimultaneous impulfe on the fame organs of fenfation, and the accident of beginning frequently at the fame time, prove fo great a fource of pleafure? Upon what is this gratuitous fuppofition founded? And though one fhould grant it, would it not follow from thence, that the fame chord fhould fucceffively and rapidly affect us with contrary fenfations, fince the vibrations are alternately coincident and difcrepant? On the other hand, how fhould the ear be fo fenfible to the fimplicity of relations, whilft, for the moft part, thefe relations are entirely unknown to him whofe organs are notwithftanding fenfibly affected with the charms of agreeable mufic? We may conceive without difficulty how the eye judges of relations; but how does the ear form fimilar judgments? Befides, why fhould certain chords which are extremely pleafing in themfelves, fuch as the fifth, lofe almoft nothing of the pleafure which they give us, when they are altered, and of confequence when the fimplicity of their relations are deftroyed; whilft other chords, which are likewife extremely agreeable, fuch as the third, become harfh almoft by the fmalleft alteration; nay, whilft the moft perfect and the moft agreeable of all chords, I mean the octave, cannot fuffer the moft inconfiderable change? Let us in fincerity confefs our ignorance concerning the genuine caufes of thefe effects. The metaphyfical conjectures concerning the accouftic organs are probably in the fame predicament with thofe which are formed concerning the organs of vifion, if one may fpeak fo, in which philofophers have even till now made fuch inconfiderable progrefs, and in all likelihood will not be furpaffed by their fucceffors (G).

Since the theory of mufic, even to thofe who confine themfelves within its limits, implies queftions from which every wife mufician will abftain, with much greater reafon fhould they avoid idle excurfions beyond the boundaries of that theory, and endeavours to inveftigate between mufic and the other fciences chimerical relations which have no foundation in nature. The fingular opinions advanced upon this fubject by fome even of the moft celebrated muficians, deferve not to be refcued from oblivion, nor refuted; and ought only to be regarded as a new proof how far men of genius may deviate from truth and tafte, when they engage in fubjects of which they are ignorant.

The rules which we have attempted to eftablifh concerning the track which every one ought to purfue in the theory of the mufical art, may fuffice to fhew our readers the end which we have propofed, and which we have endeavoured to attain in this work. We have nothing to do here (for it is proper that we repeat it), we have nothing to do with the mechanical principles of protracted and harmonic tones produced by fonorous bodies; principles which, till now, have been explored in vain, and which perhaps may be long explored with the fame fuccefs: we have ftill lefs to do with the metaphyfical caufes of thofe pleafing fenfations which are impreffed on the mind by harmony; caufes which are ftill lefs difcovered, and which, according to all appearances, will remain latent in perpetual obfcurity. We are alone concerned to fhow how the chief and moft effential laws of harmony may be deduced from one fingle experiment; and for which, if we may fpeak fo, preceding artifts have been under a neceffity of groping in the dark.

With an intention to render this work as generally ufeful as poffible, I have endeavoured to adapt it to the capacity even of thofe who are abfolutely uninftructed in mufic. To accomplifh this defign, it appeared neceffary to purfue the following plan.

43
Plan of the treatife.

To begin with a fhort introduction, in which are defined the technical terms moft frequently ufed in this art; fuch as *chord*, *harmony*, *tone*, *third*, *fifth*, *octave*, &c.

Afterwards to enter into the theory of harmony, which is explained according to M. Rameau, with all poffible perfpicuity. This is the fubject of the *Firft Part*; which, as well as the introduction, prefuppofes no other knowledge of mufic than that of the names and powers of the fyllables *ut*, *re*, *mi*, *fa*, *fol*, *la*, *fi*, which

(F) One may fee this fubject treated at greater length in the *Encyclopédie*, at the word FUNDAMENTAL.

(G) To thefe arguments others may ftill be added, which may be found under the article CONSONANCE in the *Encyclopédie*, where this queftion has been very fuccefsfully treated by M. Rouffeau.—† Thus far the author; but with refpect to his ftrictures concerning the metaphyfics of vifion, the little progrefs which philofophers have made in it, and the little probability of their being furpaffed by their fucceffors, we cannot forbear to remark, that M. D'Alembert would have been lefs precipitate and fanguine in his decifions had he read Dr Reid's *Inquiry into the human mind on the principles of common fenfe.*

which all the world knows (†).

The theory of harmony requires some arithmetical calculations, which are necessary for comparing sounds one with another. These calculations are very short, extremely simple, and conducted in such a manner as to be sensibly comprehended by every one; they demand no operation but what is clearly explained, and which every school-boy with the slightest attention may perform. Yet, that even the trouble of this may be spared to such as are not disposed to take it, I have not inserted these calculations in the body of the treatise, but transferred them to the notes, which the reader may omit, if he can satisfy himself by taking for granted the propositions contained in the work, which will be found proved in the notes.

These calculations I have not endeavoured to multiply; I could even have wished to suppress them, if it had been possible: so much did it appear to me to be apprehended that my readers might be misled upon this subject, and might either believe themselves, or at least suspect me of believing, all this arithmetic necessary to form an artist. Calculations may indeed facilitate the understanding of certain points in the theory, as of the relations between the different notes in the gammut and of the temperament; but the calculations necessary for treating of these points are so simple, and, to speak more properly, of so little importance, that nothing can require a less minute or ostentatious display. Do not let us imitate those musicians who, believing themselves geometers, or those geometers who, believing themselves musicians, fill their writings with figures upon figures; imagining, perhaps, that this apparatus is necessary to the art. The propensity of adorning their works with a false air of science, can only impose upon credulity and ignorance, and serve no other purpose but to render their treatises more obscure and less instructive. In the character of a geometer, I think I have some right to protest here (if I may be permited to express myself in this manner) against such ridiculous abuse of geometry in music.

44 Mathematical conclusions not transferable to sensible objects without caution.

This I may do with so much more reason, that in this subject the foundations of those calculations are in some manner hypothetical, and can never arise to a degree of certainty above hypothesis. The relation of the octave as 1 to 2, that of the fifth as 2 to 3, that of the third major as 4 to 5, &c. are not perhaps the genuine relations established in nature; but only relations which approach them, and such as experience can discover. For are the results of experience any thing more but mere approaches to truth?

But happily these approximated relations are sufficient, though they should not be exactly agreeable to truth, for giving a satisfactory account of those phænomena which depend on the relations of sound; as in the difference between the notes in the gammut, of the alterations necessary in the fifth and third, of the different manner in which instruments are tuned, and other facts of the same kind. If the relations of the octave, of the fifth, and of the third, are not exactly such as we have supposed them, at least no experiments can prove that they are not so; and since these relations are signified by a simple expression, since they are besides sufficient for all the purposes of theory, it would not only be useless, but even contrary to sound philosophy, should any one incline to invent other relations, to form the basis of any system of music less easy and simple than that which we have delineated in this treatise.

The *second part* contains the most essential rules of composition *, or in the other words the practice of harmony. These rules are founded on the principles laid down in the *first part;* yet those who wish to understand no more than is necessary for practice, without exploring the reasons why such practical rules are necessary, may limit the objects of their study to the *introduction* and the *second part*. They who have read the *first part*, will find at every rule contained in the *second*, a reference to that passage in the *first* where the reasons for establishing that rule are given.

* See *Composition.*

45 Some rules, on account of their intricacy, transferred to the notes.

That we may not present at once too great a number of objects and precepts, I have transferred to the notes in the second part several rules and observations which are less frequently put in practice, which perhaps it may be proper to omit till the treatise is read a second time, when the reader is well acquainted with the essential and foundamental rules explained in it.

This second part, strictly speaking, presupposes, no more than the first, any habit of singing, nor even any knowledge of music; it only requires that one should know, not even the rules and manner of intonation, but merely the position of the notes in the cleff *fa* on the fourth line, and of that of *sol* upon the second: and even this knowledge may be acquired from the work itself; for in the beginning of the second part I explain the positions of the cleffs and of the notes. Nothing else is necessary but to render it a little familiar to our memory, and we shall have no more difficulty in it.

46 All the rules of composition not to be expected in an elementary essay.

It would be wrong to expect here all the rules of composition, and especially those which direct the composition of music in several parts, and which, being less severe and indispensable, may be chiefly acquired by practice, by studying the most approved models, by

(†) The names of the seven notes used by the French are here retained, and will indeed be continued thro' the whole ensuing work; as we imagine, that, if properly associated with the sounds which they denominate, they will tend to impress these sounds more distinctly on the memory of the scholar than the letters C, D, E, F, G, A, B, from which characters, except in sol-fa'ing the notes in the diatonic series are generally named in Britain. Amongst us, in the progress of intonation, the syllables *ut, re,* and *si*, have been omitted, by which means the teachers of church-music have rendered it still more difficult to express by the four remaining denominations the various changes of the semitones in the octave. As these artificially change their places, the seven syllables above-mentioned also diversify their powers, and are variously arranged according to the intervals in which the notes they are intended to signify may be placed.

For an account of these variations, see Rousseau's musical dictionary, article GAMME. See also the Essay towards a rational system of music, by John Holden, part i. chap. 1.

Definitions.

by the aſſiſtance of a proper maſter, but above all by the cultivation of the ear and of the taſte. This treatiſe is properly nothing elſe, if I may be allowed the expreſſion, but the rudiments of muſic, intended for explaining to beginners the fundamental principles, not the practical detail of compoſition. Thoſe who wiſh to enter more deeply into this detail, will either find it in Mr Rameau's treatiſe of harmony, or in the code of muſic which he publiſhed more lately (I), or laſtly in the explication of the theory and practice of muſic by M. Bethizi (K): this laſt book appears to me clear and methodical.

One may look upon it (with reſpect to a practical detail) as a ſupplement to my own performance; I do this juſtice to the author with ſo much more cheerfulneſs, as he is entirely unknown to me, and as his animadverſions upon my work appear to me leſs ſevere than it deſerved (L).

47 Nature the eſſential miſtreſs of muſical compoſition.

Is it neceſſary to add, that, in order to compoſe muſic in a proper taſte, it is by no means enough to have familiarized with much application the principles explained in this treatiſe? Here can only be learned the mechaniſm of the art; it is the province of nature alone to accompliſh the reſt. Without her aſſiſtance, it is no more poſſible to compoſe agreeable muſic by having read theſe elements, than to write verſes in a proper manner with the Dictionary of Richelet. In one word, it is the elements of muſic alone, and not the principles of genius, that the reader may expect to find in this treatiſe.

Such was the aim I purſued in its compoſition, and ſuch ſhould be the ideas of the reader in its peruſal. Once more let me add, that to the diſcovery of its fundamental principles I have not the remoteſt claim. The ſole end which I propoſed was to be uſeful; to reach that end, I have omitted nothing which appeared neceſſary, and I ſhould be ſorry to find my endeavours unſucceſsful.

DEFINITIONS OF SEVERAL TECHNICAL TERMS.

I. *What is meant by Melody, by Chord, by Harmony, by Interval.*

48 Melody, what.

1. Melody is nothing elſe but a ſeries of ſounds which ſucceed one to another in a manner agreeable to the ear.

49 Chord and harmony, what.

2. That is called a *chord* which ariſes from the mixture of ſeveral ſounds heard at the ſame time; and harmony is properly a ſeries of chords which in their ſucceſſion one to another delights the ear. A ſingle chord is likewiſe ſometimes called *harmony*, to ſignify the coaleſcence of ſounds which that chord creates, and the ſenſation produced in the ear by that coaleſcence. We ſhall occaſionally uſe the word *harmony* in this laſt ſenſe, but in ſuch a manner as never to leave our meaning ambiguous.

3. In melody and harmony, the diſtance between one ſound and another is called an *interval*; and this is increaſed or diminiſhed as the ſounds between which it intervenes are higher or lower one than the other. See *Interval*.

4. That we may learn to diſtinguiſh the intervals, and the manner of perceiving them, let us take the ordinary ſcale *ut, re, mi, fa, ſol, la, ſi, UT,* C, D, E, F, G, A, B, C, which every perſon whoſe ear or voice is not extremely falſe naturally modulates. Theſe are the obſervations which will occur to us in ſinging this gammut.

50 Account of the ſimple intervals.

The ſound *re* is higher or ſharper than the ſound *ut*, the ſound *mi* higher than the ſound *re*, the ſound *fa* higher than the ſound *mi*, &c. and ſo through the whole octave; ſo that the interval or the diſtance from the ſound *ut* to the ſound *re*, is leſs than the interval or diſtance between the ſound *ut* and the ſound *mi*, the interval from *ut* to *mi* is leſs than that between *ut* and *fa*, &c. and in ſhort that the interval from the firſt to the ſecond *ut* is the greateſt of all. To diſtinguiſh the firſt from the ſecond *ut*, I have marked the laſt with capital letters.

51 The diſtinction between ſtrong and faint, or acute and grave.

5. In general, the interval between two ſounds is proportionably greater, as one of theſe ſounds is higher or lower with relation to the other: but it is neceſſary to obſerve, that two ſounds may be equally high or low, though unequal in their force. The ſtring of a violin touched with a bow produces always a ſound equally high, whether ſtrongly or faintly ſtruck; the ſound will only have a greater or leſſer degree of ſtrength. It is the ſame with vocal modulation; let any one form a ſound by gradually impelling or ſwelling the voice, the ſound may be perceived to increaſe in its energy, whilſt it continues always equally low or equally high.

52 Between tonic and ſemitonic intervals.

6. We muſt likewiſe obſerve concerning the ſcale, that the intervals between *ut* and *re*, between *re* and *mi*, between *fa* and *ſol*, between *ſol* and *la*, between *la* and *ſi*, are equal, or at leaſt nearly equal; and that the intervals between *mi* and *fa*, and between *ſi* and *ut*, are likewiſe equal among themſelves, but conſiſt almoſt only of half the former. This fact is known and recogniſed by every one: the reaſon for it ſhall be given in the ſequel; in the mean time every one may aſcertain its reality by the aſſiſtance of an experiment (A).

7. It

(I) From my general recommendation of this code, I except the reflections on the principles of ſound which are at the end, and which I ſhould not adviſe any one to read.

(K) Printed at Paris by Lambert in the year 1754.

(L) That criticiſm and my anſwers may be ſeen in the *Journeaux Economiques* of 1752.

(A) This experiment may be eaſily tried. Let any one ſing the ſcale of *ut, re, mi, fa, ſol, la, ſi, UT,* C, D, E, F, G, A, B, C, it will be immediately obſerved without difficulty, that the laſt four notes of the octave *ſol, la, ſi, UT,* G, A, B, C, are quite ſimilar to the firſt *ut, re, mi, fa*; inſomuch, that if, after having ſung this ſcale, one would chooſe to repeat it, beginning with *ut* in the ſame tone which was occupied by *ſol* in the former ſcale, the note *re* of the laſt ſcale would have the ſame ſound with the note *la* in the firſt, the *mi* with the *ſi*, and the *fa* with the *ut*.

From whence it follows, that the interval between *ut* and *re*, is the ſame as between *ſol* and *la*; between *re* and

Definitions.

7. It is for this reaſon that they have called the interval from *mi* to *fa*, and from *ſi* to *ut*, a ſemitone; whereas thoſe between *ut* and *re*, *re* and *mi*, *fa* and *ſol*, *ſol* and *la*, *la* and *ſi*, are tones.

* See the figure marked A.

The *tone* is likewiſe called a *ſecond major* *, and the *ſemitone* a *ſecond minor* †.

* See *Interval*.

8. To deſcend or riſe diatonically, is to deſcend or riſe from one ſound to another by the interval of a tone or of a ſemitone, or in general by ſeconds, whether major or minor; as from *re* to *ut*, or from *ut* to *re*; from *fa* to *mi*, or from *mi* to fa.

II. *The Terms by which the different Intervals of the Gammut are denominated.*

53 Third minor, what.

9. An interval compoſed of a tone and a ſemitone, as from *mi* to *ſol*, from *la* to *ut*, or from *re* to *fa*, is called a *third minor*.

54 Third major, what.

An interval compoſed of two full tones, as from *ut* to *mi*, from *fa* to *la*, or from *ſol* to *ſi*, is called a *third major*.

55 Fourth, what

An interval compoſed of two tones and a ſemitone, as from *ut* to *fa*, or from *ſol* to *ut*, is called a *fourth* ‡.

56 Triton, what.

An interval conſiſting of three full tones, as from *fa* to *ſi*, is called a *triton* or *fourth redundant*.

57 Fifth, what.

An interval conſiſting of three tones and a ſemitone, as from *ut* to *ſol*, from *fa* to *ut*, from *re* to *la*, or from *mi* to *ſi*, &c. is called a *fifth*.

58 Sixth minor, what.

An interval compoſed of three tones and two ſemitones, as from *mi* to *ut*, is called a *ſixth minor*.

59 Sixth major, what.

An interval compoſed of four tones and a ſemitone, as from *ut* to *la*, is called a *ſixth major*.

60 Seventh minor, what.

An interval conſiſting of four tones and two ſemitones, as from *re* to *ut*, is called a *ſeventh minor*.

An interval compoſed of five tones and two ſemitones, as from *ut* to *ſi*, is called a *ſeventh major*. Definitions.

61 Seventh major, what.

And in ſhort, an interval conſiſting of five tones and two ſemitones, as from *ut* to *UT*, is called an *octave*.

62 Octave, what.

A great many of the intervals which have now been mentioned, are ſtill ſignified by other names, as may be ſeen in the beginning of the ſecond part; but thoſe which we have now given are the moſt common, and the only terms which our preſent purpoſe demands.

63 Uniſon, what.

10. Two ſounds equally high, or equally low, however unequal in their force, are ſaid to be in *uniſon* one with the other.

11. If two ſounds form between them any interval, whatever it be, we ſay, that the higheſt when aſcending is in that interval with relation to the loweſt; and when deſcending, we pronounce the loweſt in the ſame interval with relation to the higheſt. Thus in the third minor *mi*, *ſol*, where *mi* is the loweſt and *ſol* the higheſt ſound, *ſol* is a third minor from *mi aſcending*, and *mi* is third minor from *ſol in deſcending*.

12. In the ſame manner, if, ſpeaking of two ſonorous bodies, we ſhould ſay, that the one is a fifth above the other *in aſcending*, this infers that the ſound given by the one is at the diſtance of a fifth *aſcending* from the ſound given by the other.

III. *Of Intervals greater than the Octave.*

See fig. B.

13. If after having ſung the ſcale *ut*, *re*, *mi*, *fa*, *ſol*, *la*, *ſi*, *UT*, one would carry this ſcale ſtill farther in aſcent, it would be diſcovered without difficulty that a new ſcale would be formed, UT, RE, MI, FA, &c. entirely ſimilar to the former, and of which the ſounds will be an octave aſcending, each to its correſpondent note in the former ſcale: thus RE, the ſecond note of the ſecond ſcale, will be an octave in aſcent to the *re* of

and *mi*, as between *la* and *ſi*; and *mi* and *fa*, as between *ſi* and *ut*.

It will likewiſe be found, that from *re* to *mi*, from *fa* to *ſol*, there is the ſame interval as from *ut* to *re*. To be convinced of this, we need only ſing the ſcale once more; then ſing it again, beginning with *ut*, in this laſt ſcale, in the ſame tone which was given to *re* in the firſt; and it will be perceived, that the *re* in the ſecond ſcale will have the ſame ſound, at leaſt as far as the ear can diſcover, with the *mi* in the former ſcale; from whence it follows, that the interval between *re* and *mi* is, at leaſt as far as the ear can perceive, equal to that between *ut* and *re*. It will alſo be found, that the interval between *fa* and *ſol* is, ſo far as our ſenſe can determine, the ſame with that between *ut* and *re*.

This experiment may perhaps be tried with ſome difficulty by thoſe who are not inured to form the notes and change the key; but ſuch may very eaſily perform it by the aſſiſtance of a harpſichord, by means of which the performer will be ſaved the trouble of retaining the ſounds in one intonation whilſt he performs another. In touching upon this harpſichord the keys *ſol*, *la*, *ſi*, *ut*, and in performing with the voice at the ſame time *ut*, *re*, *mi*, *fa*, in ſuch a manner that the ſame ſound may be given to *ut* in the voice with that of the key *ſol* in the harpſichord, it will be found that *re* in the vocal intonation ſhall be the ſame with *la* upon the harpſichord, &c.

It will be found likewiſe by the ſame harpſichord, that if one ſhould ſing the ſcale beginning with *ut* in the ſame tone with *mi* on the inſtrument, the *re* which ought to have followed *ut*, will be higher by an extremely perceptible degree than the *fa* which follows *mi*: thus it may be concluded, that the interval between *mi* and *fa* is leſs than that between *ut* and *re*; and if one would riſe from *fa* to another ſound which is at the ſame diſtance from *fa* as *fa* from *mi*, he would find in the ſame manner, that the interval from *mi* to this new ſound is almoſt the ſame as that between *ut* and *re*. The interval then from *mi* to *fa* is nearly half of that between *ut* and *re*.

Since then, in the ſcale thus divided, *ut*, *re*, *mi*, *fa*, / *ſol*, *la*, *ſi*, *Ut*,
the firſt diviſion is perfectly like the laſt; and ſince the intervals between *ut* and *re*, between *re* and *mi*, and between *fa* and *ſol*, are equal; it follows, that the intervals between *ſol* and *la*, and between *la* and *ſi*, are likewiſe equal to every one of the three intervals between *ut* and *re*, between *re* and *mi*, and between *fa* and *ſol*; and that the intervals between *mi* and *fa* and between *ſi* and *ut* are alſo equal, but that they only conſtitute one half of the others.

Definitions. of the firft fcale; in the fame manner MI fhall be the octave to *mi*, &c. and fo of the reft.

64 Ninth, what. 14. As there are nine notes from the firft *ut* to the fecond RE, the interval between thefe two founds is called a *ninth*, and this ninth is compofed of fix full tones and two femitones. For the fame reafon the interval from *ut* to FA is called an *eleventh*, and the interval between *ut* and SOL, a *twelfth*, &c.

65 Eleventh and twelfth, what. It is plain that the *ninth* is the octave of the *fecond*, the *eleventh* of the *fourth*, and the *twelfth* of the *fifth*, &c.

§ See *Interval* and *Double Octave*. The octave above the octave of any found is called a *double octave* §; the octave of the double octave is called a *triple octave*; and fo of the reft.

The double octave is likewife called a *fifteenth*; and for the fame reafon the double octave of the third is called a *feventeenth*, the double octave of the fifth a *nineteenth*, &c. (B)

IV. *What is meant by Sharps and Flats.*

66 Sharp and flats, what. See *Interval*. 15. It is plain that one may imagine the five tones which enter into the fcale, as divided each into two femitones; thus one may advance from *ut* to *re*, forming in his progrefs an intermediate found, which fhall be higher by a femitone than *ut*, and lower in the fame degree than *re*. A found in the fcale is called *fharp*, when it is raifed by a femitone; and it is marked with this character ※: thus *ut* ※ fignifies *ut fharp*; that it is to fay, *ut* raifed by a femitone above its pitch in the natural fcale. A found in the fcale depreffed by a femitone is called *flat*, and is marked thus, ♭: thus *la*♭ fignifies *la flat*, or *la* depreffed by a femitone. Definitions.

V. *What is meant by Confonances and Diffonances.*

16. A chord compofed of founds whofe union or coalefcence pleafes the ear is called a *confonance*; and the founds which form this chord are faid to be confonant one with relation to the other. The reafon of this denomination is, that a chord is found more perfect, as the founds which form it coalefce more clofely among themfelves. 67 Confonance, what. See *Chord*.

17. The octave of a found is the moft perfect of confonances of which that found is fufceptible; then the fifth, afterwards the third, &c. This is a fact founded on experiment.

18. A number of founds fimultaneoufly produced whofe union is difpleafing to the ear is called a *diffonance*, and the founds which form it are faid to be diffonant one with relation to the other. The fecond, the triton, and the feventh of a found, are diffonants with relation to it. Thus the fonnds *ut re*, *ut fi*, or *fa fi*, &c. fimultaneoufly heard, form a diffonance. The reafon which renders diffonance difagreeable, is, that the founds which compofe it feem by no means coalefcent to the ear, and are heard each of them by itfelf as diftinct founds, tho' produced at the fame time. 68 Diffonance, what. See *Difcord*.

PART

(B) Let us fuppofe two vocal ftrings formed of the fame matter, of the fame thicknefs, and equal in their tenfion, but unequal in their length, it will be found by experience,

1ft, That if the fhorteft is equal to half the longeft, the found which it will produce muft be an octave above the found produced by the longeft.

2dly, That if the fhorteft conftitutes a third part of the longeft, the found which it produces muft be a twelfth above the found produced by the longeft.

3dly, That if it conftitutes the fifth part, its found will be a feventeenth above.

Befides, it is a truth demonftrated and generally admitted, that in proportion as one mufical ftring is lefs than another, the vibrations of the leaft will be more frequent (that is to fay, its departures and returns through the fame fpace), in the fame time; for inftance, in an hour, a minute, a fecond, &c. in fuch a manner that one ftring which conftitutes a third part of another, forms three vibrations, whilft the largeft has only accomplifhed one. In the fame manner a ftring which is one half lefs than another, performs two vibrations, whilft the other only completes one; and a ftring which is only the fifth part of another, will perform five vibrations in the fame time which is occupied by the other in one.

From thence it follows, that the found of a ftring is proportionally higher or lower, as the number of its vibrations is greater or fmaller in a given time; for inftance, in a fecond.

It is for that reafon that if we reprefent any found whatever by 1, one may reprefent the octave above by 2, that is to fay, by the number of vibrations formed by the ftring which produces the octave, whilft the longeft ftring only vibrates once; in the fame manner we may reprefent the twelfth above the found 1 by 3, the feventeenth major above by 5, &c. But it is very neceffary to remark, that by thefe numerical expreffions, we do not pretend to compare founds as fuch; for founds in themfelves are nothing but mere fenfations, and it cannot be faid of any fenfation that it is double or triple to another: thus the expreffions 1, 2, 3, &c. employed to denominate a found, its octave above, its twelfth above, &c. fignify only, that if a ftring performs a certain number of vibrations, for inftance, in a fecond, the ftring which is in the octave above fhall double the number in the fame time, the ftring which is in the twelfth above fhall triple it, &c.

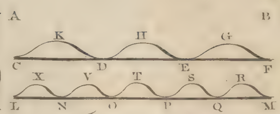
Thus to compare founds among themfelves is nothing elfe than to compare among themfelves the numbers of vibrations which are formed in a given time by the ftrings that produce thefe founds.

Tone tone semitone tone tone tone semitone

A. ut re mi fa sol la si VT

B. ut re mi fa sol la si VT RE MI FA SOL &

Scale first. Scale Second.

C


The Chromatic Species.

The diatonic Scale of the Greeks.

D
Si Ut Re Mi Fa Sol La
Sol Ut Sol Ut Fa Ut Fa
The Fundamental bass.

K
Scale.
Sol Sol &c.
Ut Mi Sol*
The Fundamental bass.

E
Ut Re Mi Fa Sol Sol La Si Ut
Ut Sol Ut Fa Ut Sol Re Sol Ut
The Fundamental bass

L
Scale
Ut Mi Si*
Ut Mi Sol*
The Fundamental bass.

F. VT, VT*, re, re*, mi, mi*, fa*, SOL, sol*, LA, la*, si si*, ut, ut*, RE, RE*, MI, MI*,

Scale first. Scale Second.

The first Scale of the minor mode.

G
Sol* La Si Ut Re Mi Fa
Third minor — Third minor — Third minor
Mi La Mi La Re La Re
The undamental bass.

N
Scale
Mi♭ Mi Mi Mi Mi*
Ut Ut La Ut Ut
The Fundamental bass.

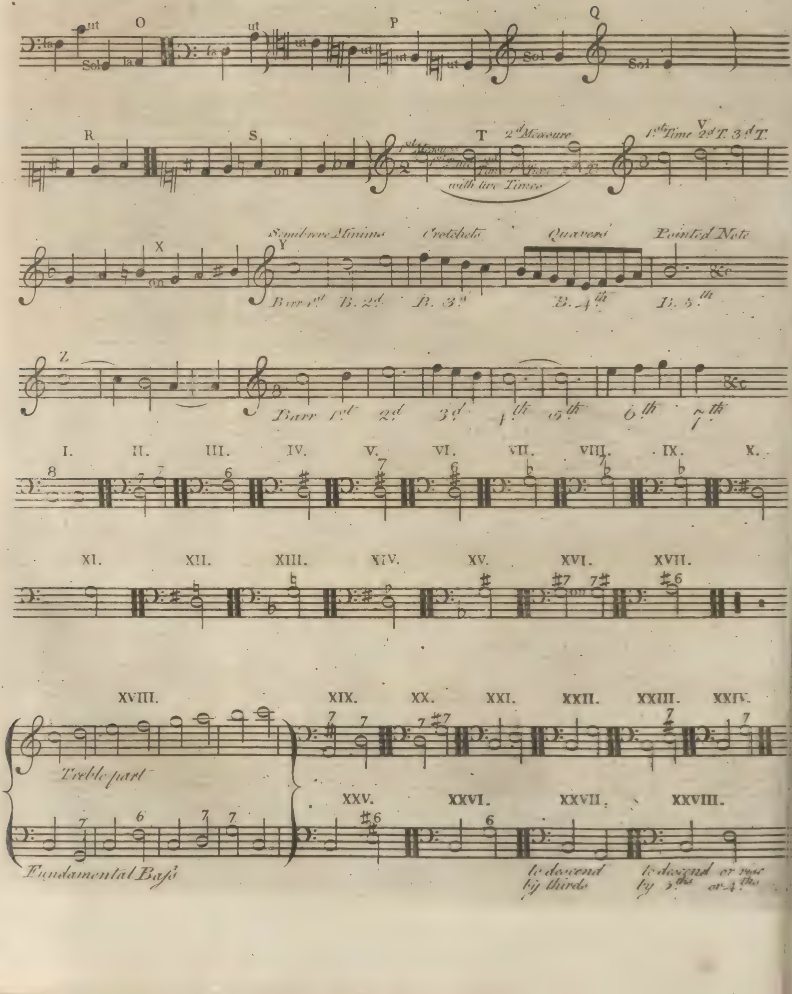
The second scale of the minor mode.

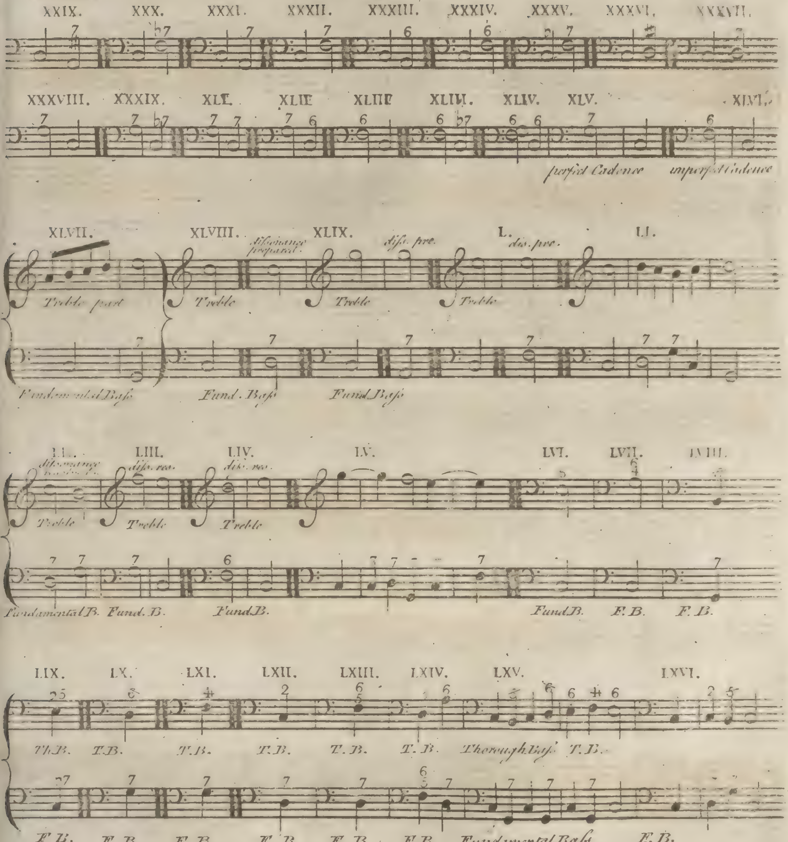
H
La Si Ut Re Mi mi fa* Sol* La
La Mi La Re La Mi Si Mi La
The Fundamental bass.

M
Scale.
Fa Mi Mi Re
Fa Ut Mi Si
The Fundamental bass.

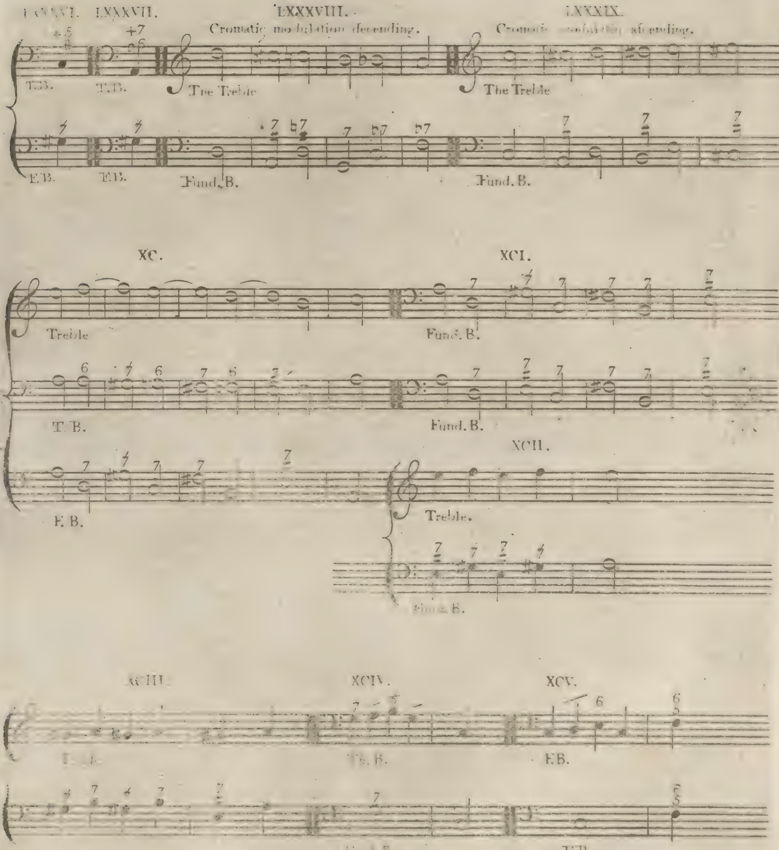
I
Scale.
Ut Re Mi Fa Sol La Si Ut
Ut Sol Ut Fa Ut Re Sol Ut

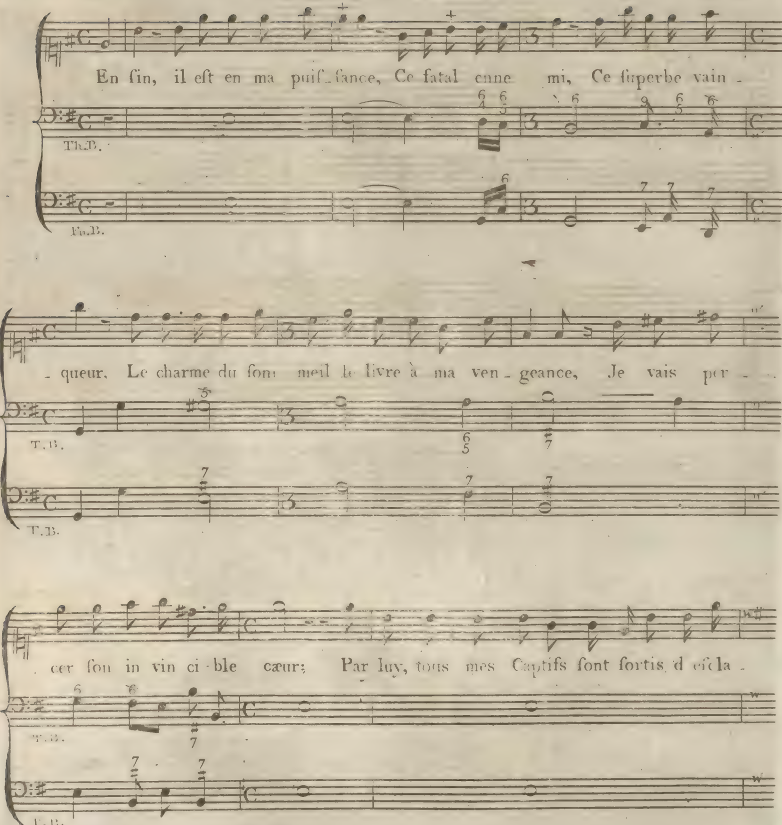
A. Bell Sculp.t

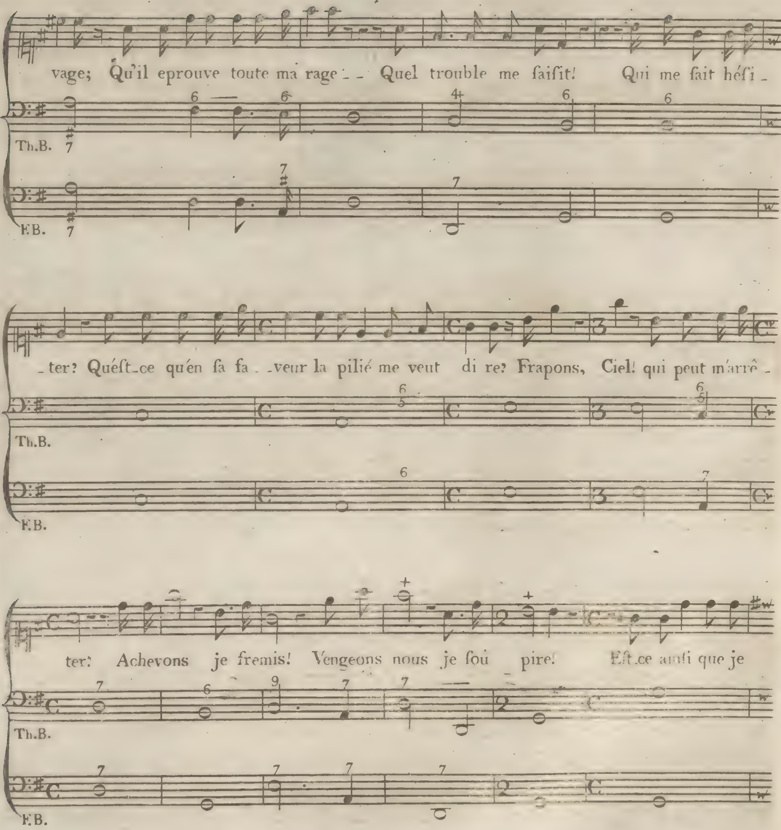

O
P
Q
ut
Sol
la
R
S
T
V
2d Measure
with two Times
1st Time 2d T. 3d T.
X
Y
Semibreve Minims
Crotchets
Quavers
Pointed Note
Barr 1st B. 2d B. 3d B. 4th B. 5th
Z
Barr 1st 2d 3d 4th 5th 6th 7th
I. II. III. IV. V. VI. VII. VIII. IX. X.
XI. XII. XIII. XIV. XV. XVI. XVII.
XVIII.
Treble part
Fundamental Bass
XIX. XX. XXI. XXII. XXIII. XXIV.
XXV. XXVI. XXVII. XXVIII.
to descend by thirds
to descend or rise by 5ths or 4ths

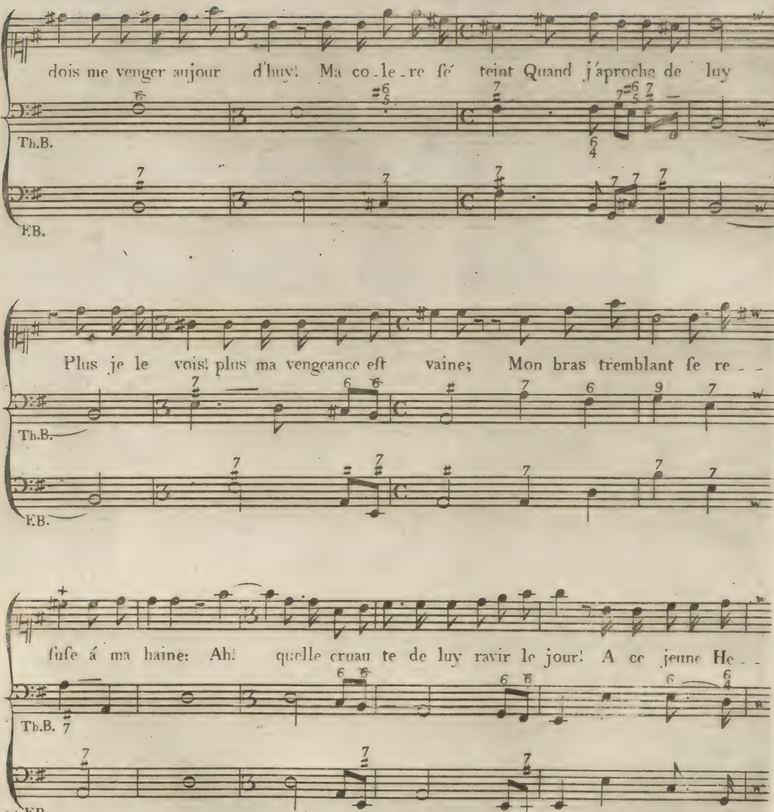

XXIX. XXX. XXXI. XXXII. XXXIII. XXXIV. XXXV. XXXVI. XXXVII.
XXXVIII. XXXIX. XLI. XLII. XLIII. XLIV. XLV. XLVI.
perfect Cadence
imperfect Cadence
XLVII. XLVIII. XLIX. L. LI.
dissonance prepared.
diss. pre.
dis. pre.
Treble part
Treble
Fundamental Bass
Fund. Bass
LII. LIII. LIV. LV. LVI. LVII. LVIII.
diss. res.
Fundamental B.
Fund. B.
F. B.
LIX. LX. LXI. LXII. LXIII. LXIV. LXV. LXVI.
Th. B.
T. B.
Thorough Bass
Fundamental Bass

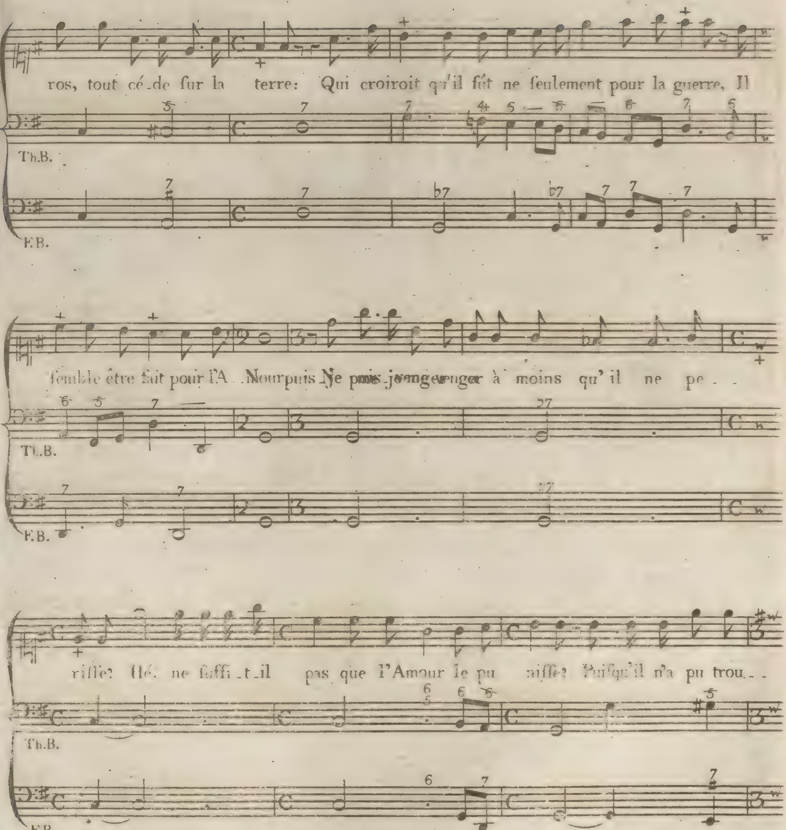

LXVII.
Treble.
Through Bass
Fundamental Bass
LXVIII.
Treble.
Thro B.
Fund. B.
LXIX.
The Key.
T. B. or Key
The Sensible Note
Key
Fund. B.
LXX.
T. B.
Sen. N.
Key
LXXI.
Th. B.
Fund. B.
LXXII.
F. B.
LXXIII.
F. B.
LXXIV.
F. B.
Broken Cadence
LXXV.
F. B.
Interrupted Cadence
LXXVI.
LXXVII.
LXXVIII.
LXXIX.
LXXX.
LXXXI.
LXXXII.
LXXXIII.
LXXXIV.
LXXXV.
T. B.
F. B.
Fund. B.

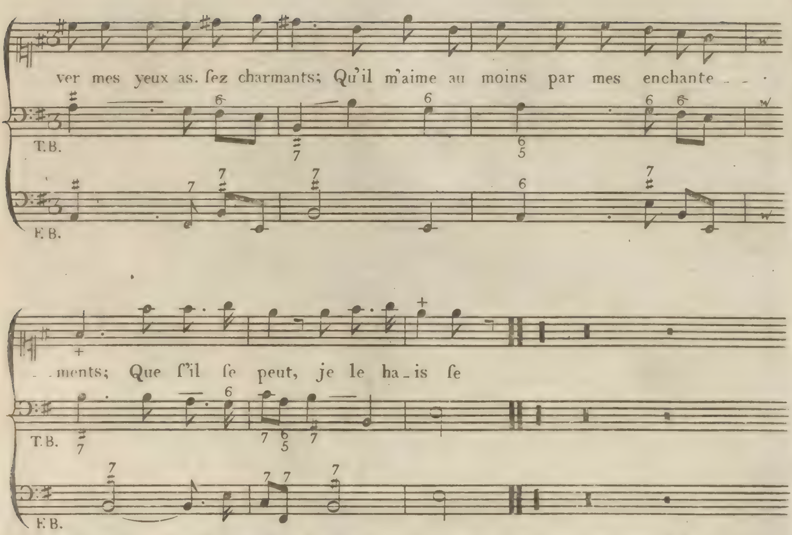

LXXXVII.
LXXXVIII.
Cromatic modulation decending.
LXXXIX.
T.B.
T.B.
The Treble
The Treble
F.B.
F.B.
Fund. B.
Fund. B.
XC.
XCI.
Treble
Fund. B.
T. B.
Fund. B.
XCII.
F. B.
Treble.
XCIV.
XCV.
F.B.
F.B.


En ſin, il eſt en ma puiſ_ſance, Ce fatal enne mi, Ce ſuperbe vain _
_ queur. Le charme du ſom meil le livre à ma ven _ geance, Je vais per _
cer ſon in vin ci - ble cæur; Par luy, tous mes Captifs ſont ſortis d eſcla _
Th.B.
T.B.


vage; Qu'il eprouve toute ma rage - - Quel trouble me faifit! Qui me fait héfi -
Th.B.
E.B.
- ter? Quéft-ce qu'én fa fa - -veur la pilié me veut di re? Frapons, Ciel! qui peut m'arrê -
Th.B.
E.B.
ter! Achevons je fremis! Vengeons nous je fou - pire!
Th.B.
E.B.


dois me venger aujour d'huy! Ma co_le_re se teint Quand j'aproche de luy
Th.B.
F.B.
Plus je le vois! plus ma vengeance est vaine; Mon bras tremblant se re_ _
Th.B.
F.B.
fuse á ma haine: Ah! quelle cruau te de luy ravir le jour! A ce jeune He_ _
Th.B.
F.B.


ros, tout cé_de ſur la terre: Qui croiroit qu'il fût ne ſeulement pour la guerre, Il
Th.B.
F.B.
ſemble être fait pour l'A_Nourpuis Je puis_je venger à moins qu' il ne pe_ _
Th.B.
F.B.
riſſe? Hé. ne ſuffi_t_il pas que l'Amour le pu niſſe? Puiſqu'il n'a pu trou_ _
Th.B.
F.B.



Tranſlation. Intended to give ſuch Readers as do not underſtand French, an idea of the Song.

At length the victim in my power I ſee,
This fatal year reſigns him to my rage;
Subdued by ſleep he lies, and leaves me free,
With chaſtening hand my fury to aſſwage.
That mighty heart invincible and fierce,
Which all my captives free'd from ſervile chains;
That mighty heart, my vengeful hand ſhall pierce,
My rage inventive wanton in his pains.
Ha. in my ſoul what perturbation reigns!
What would compaſsion in his favour plead?
Strike, hand. O heaven! what charm thy force reſtrains?
Obey my wrath. I ſigh; yet let it bleed.
And is it thus my juſt revenge improves
The fair occaſion to chaſtize my foe?
As I approach, a ſofter paſsion moves,
And all my boaſting fury melts in wo.
Trembling, relaxed, and faithleſs to my hate,
The dreadful taſk this coward arm declines.

How cruel thus to urge his inſtant fate,
Depriv'd of life amid his great deſigns!
In youth how blooming! what a heavenly grace,
Thro' all his form, reſiſtleſs power diſplays!
How ſweet the ſmile that dwells upon his face,
Relentleſs rage diſarming whilſt I gaze!
Tho' to the proweſs of his conquering arms
Earth ſtood with all her hoſts oppoſed in vain;
Yet is he form'd to ſpread more mild alarms,
And bind all nature in a ſofter chain.
Can then his blood, his precious blood, alone
Extinguiſh all the vengeance in my heart?
Tho' ſtill ſurviving, might he not atone
For all the wrongs I feel, by gentler ſmart?
Since all my charms, unfeeling, he defies,
Let Magic force his ſtubborn ſoul ſubdue;
Whilſt I, inflexible to tears and ſighs,
With hate (if I can hate) his peace purſue.

Pl. 16.

Part I. THEORY of HARMONY.

Chap. I. *Preliminary and Fundamental Experiments.*

Experiment I.

19. WHEN a ſonorous body is ſtruck till it gives a ſound, the ear, beſides the principal ſound and its octave, perceives two other ſounds very high, of which one is the twelfth above the principal ſound, that is to ſay, the octave to the fifth of that ſound; and the other is the ſeventeenth major above the ſame ſound, that is to ſay, the double octave of its third major.

19. This experiment is peculiarly ſenſible upon the thick ſtrings of the violoncello, of which the ſound being extremely low, gives to an ear, though not very much practiſed, an opportunity of diſtinguiſhing with ſufficient eaſe and clearneſs the twelfth and ſeventeenth now in queſtion (c).

21. The principal ſound is called the *generator* *; and

* See Generator.

(c) Since the octave above the ſound 1 is 2, the octave below that ſame ſound ſhall be $\frac{1}{2}$; that is to ſay, that the ſtring which produces this octave ſhall have performed half its vibration whilſt the ſtring which produces the ſound 1 ſhall have completed one. To obtain therefore the octave above any ſound, the operator muſt multiply the quantity which expreſſes the ſound by 2; and to obtain the octave below, he muſt on the contrary divide the ſame quantity by 2.

It is for that reaſon that if any ſound whatever, for inſtance *ut*, is denominated	1
Its octave above will be	2
Its double octave above	4
Its triple octave above	8
In the ſame manner its octave below will be	$\frac{1}{2}$
Its double octave below	$\frac{1}{4}$
Its triple octave below,	$\frac{1}{8}$
And ſo of the reſt.	
Its twelfth above	3
Its twelfth below	$\frac{1}{3}$
Its ſeventeenth major above	5
Its ſeventeenth major below	$\frac{1}{5}$

The fifth then above the ſound 1 being the octave beneath the twelfth, ſhall be, as we have immediately obſerved, $\frac{3}{2}$; which ſignifies that this ſtring performs $\frac{3}{2}$ vibrations, that is to ſay one vibration and a half, during a ſingle vibration of the ſtring which gives the ſound 1.

To obtain the fourth above the ſound 1, we muſt take the twelfth below that ſound, and the double octave above that twelfth. In effect, the twelfth below *ut*, for inſtance, is *fa*, of which the double octave *fa* is the fourth above *ut*. Since then the twelfth below 1 is $\frac{1}{3}$, it follows that the double octave above this twelfth, that is to ſay, the fourth from the ſound 1 in aſcending, will be $\frac{1}{3}$ multiplied by 4, or $\frac{4}{3}$.

In ſhort, the third major being nothing elſe but the double octave beneath the ſeventeenth, it follows, that the third major above the ſound 1 will be 5 divided by 4, or in other words $\frac{5}{4}$.

The third major of a ſound, for inſtance the third major *mi*, from the ſound *ut*, and its fifth *ſol*, form between them a third minor *mi, ſol*; now *mi* is $\frac{5}{4}$, and *ſol* $\frac{3}{2}$, by what has been immediately demonſtrated: from whence it follows, that the third minor, or the interval between *mi* and *ſol*, ſhall be expreſſed by the relation of the fraction $\frac{5}{4}$ to the fraction $\frac{3}{2}$.

To determine this relation, it is neceſſary to remark, that $\frac{5}{4}$ are the ſame thing with $\frac{10}{8}$, and that $\frac{3}{2}$ are the ſame thing with $\frac{12}{8}$: ſo that $\frac{5}{4}$ ſhall be to $\frac{3}{2}$ in the ſame relation as $\frac{10}{8}$ to $\frac{12}{8}$; that is to ſay, in the ſame relation as 10 to 12, or as 5 to 6. If, then, two ſounds form between themſelves a third minor, and that the firſt is repreſented by 5, the ſecond ſhall be expreſſed by 6; or what is the ſame thing, if the firſt is repreſented by 1, the ſecond ſhall be expreſſed by $\frac{6}{5}$.

Thus the third minor, an harmonic ſound which is even found in the protracted and coaleſcent tones of a ſonorous body between the ſound *mi* and *ſol*, an harmonic of the principal ſound, may be expreſſed by the fraction $\frac{6}{5}$.

N. B. One may ſee by this example, that in order to compare two ſounds one with another which are expreſſed by fractions, it is neceſſary firſt to multiply the numerator of the fraction which expreſſes the firſt by the denominator of the fraction which expreſſes the ſecond, which will give a primary number; as here the numerator 5 of the fraction $\frac{5}{4}$, multiplied by 2 of the fraction $\frac{3}{2}$ has given 10. Afterwards may be multiplied the numerator of the ſecond fraction by the denominator of the firſt which will give a ſecondary number, as here 12 is the product of 4 multiplied by 3; and the relation between theſe two numbers (which in the preceding example are 10 and 12), will expreſs the relation between theſe ſounds, or, what is the ſame thing, the interval which there is between the one and the other; in ſuch a manner, that the farther the relation between theſe ſounds departs from unity, the greater the interval will be.

Such is the manner in which we may compare two ſounds one with another whoſe numerical value is known. We ſhall now ſhow the manner how the numerical expreſſion of a ſound may be obtained, when the relation which it ought to have with another ſound is known whoſe numerical expreſſion is given.

Let

and the two other sounds which it produces, and with which it is accompanied, are, inclusive of its octave, called its *harmonics* §.

69 Generator what.

§ See *Harmonic*.

Experiment II.

22. There is no person insensible of the resemblance which subsists between any sound and its octave, whether above or below. These two sounds, when heard together, almost entirely coalesce in the organ of sensation. We may besides be convinced (by two facts which are extremely simple) of the facility with which one of these sounds may be taken for the other.

Let it be supposed that any person has an inclination to sing a tune, and having at first begun this air upon a pitch too high or too low for his voice, so that he is obliged, lest he should strain himself too much, to sing the tune in question on a key higher or lower than the first; I affirm, that, without being initiated in the art of music, he will naturally take his new key in the octave below or the octave above the first; and that in order to take this key in any other interval except the octave, he will find it necessary to exert a sensible degree of attention. This is a fact of which we may easily be persuaded by experience.

Another fact. Let any person sing a tune in our presence, and let it be sung in a tone too high or too low for our voice; if we wish to join in singing this air, we naturally take the octave below or above, and frequently, in taking this octave, we imagine it to be the unison (D).

Chap. II. *The Origin of the Modes Major and Minor; of the most natural Modulation, and the most perfect Harmony.*

70 Fundamental and harmonics, what.

23. To render our ideas still more precise and permanent, we shall call the tone produced by the sonorous body *ut*: it is evident, by the first experiment, that this sound is always attended by its 12th and 17th major; that is to say, with the octave of *sol*, and the double octave of *mi*.

24. This octave of *sol* then, and this double octave of *mi*, produce the most perfect chord which can be joined with *ut*, since that chord is the work and choice of nature (E).

25. For the same reason, the modulation formed by *ut* with the octave of *sol* and the double octave of *mi*, sung one after the other, would likewise be the most simple and natural of all modulations which do not descend or ascend directly in the diatonic order, if our voices had sufficient compass to form intervals so great without difficulty: but the ease and freedom with which we can substitute its octave to any sound, when it is more convenient for the voice, afford us the means of representing this modulation. 71 Harmony reduced to chords, fifths, and octaves.

26. It is on this account that, after having sung the tone *ut*, we naturally modulate the third *mi*, and the fifth *sol*, instead of the double octave of *mi*, and the octave of *sol*; from whence we form, by joining the octave of the sound *ut*, this modulation, *ut*, *mi*, *sol*, *ut*, which in effect is the simplest and easiest of them all; and which likewise has its origin even in the protracted and compounded tones produced by a sonorous body. 72 Mode major, what.

27. The modulation *ut*, *mi*, *sol*, *ut*, in which the chord *ut*, *mi*, is a third major, constitutes that kind of harmony or melody which we call the *mode major*; from whence it follows, that this mode results from the immediate operation of nature. See *Mode*. See likewise *Interval*.

28. In the modulation *ut*, *mi*, *sol*, of which we have now been treating, the sounds *mi* and *sol* are so proportioned one to the other, that the principal sound *ut* (art. 19.) causes both of them to resound; but the second tone *mi* does not cause *sol* to resound, which only forms the interval of a third minor. 73 Mode minor, what.

29. Let us then imagine, that, instead of this sound *mi*, one should substitute between the sounds *ut sol* another note which (as well as the sound *ut*) has the power of causing *sol* to resound, and which is, however, different from the sound *ut*; the sound which we explore ought to be such, by art. 19. that it may have for its 17th major *sol*, or one of the octaves of *sol*; of consequence the sound which we seek ought to be a 17th major below *sol*, or, what is the same thing, a third major below the same *sol*. Now the sound *mi* being a third minor beneath *sol*, and the third major being (art. 9.) greater by a semitone than the third minor, it follows, that the sound of which we are

Let us suppose, for example, that the third major of the fifth $\frac{3}{2}$ is sought. That third major ought to be, by what has been shown above, the $\frac{5}{4}$ of the fifth; for the third major of any sound whatever is the $\frac{5}{4}$ of that sound. We must then look for a fraction which expresses the $\frac{5}{4}$ of $\frac{3}{2}$; which is done by multiplying the numerators and denominators of both fractions one by the other, from whence results the new fraction $\frac{15}{8}$. It will likewise be found that the fifth of the fifth is $\frac{9}{4}$, because the fifth of the fifth is the $\frac{3}{2}$ of $\frac{3}{2}$.

Thus far we have only treated of fifths, fourths, thirds major and minor, in ascending; now it is extremely easy to find by the same rules the fifths, fourths, thirds major and minor in descending. For suppose *ut* equal to 1, we have seen that its fifth, its fourth, its third, its major and minor in ascending, are $\frac{3}{2}$, $\frac{4}{3}$, $\frac{5}{4}$, $\frac{6}{5}$. To find its fifth, its fourth, its third major and minor in descending, nothing more is necessary than to reverse these fractions, which will give $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$.

(D) It is not then imagined that we change the value of a sound in multiplying or dividing it by 2, by 4, or by 8, &c. the number which expresses these sounds, since by these operations we do nothing but take the simple, double, or triple octave, &c. of the sound in question, and that a sound coalesces with its octave.

(E) The chord formed with the twelfth and seventeenth major united with the principal sound, being exactly conformed to that which is produced by nature, is likewise for that reason the most agreeable of all; especially when the composer can proportion the voices and instruments together in a proper manner to give this chord its full effect. M. Rameau has executed this with the greatest success in the opera of *Pygmalion*, page 34. where Pygmalion sings with the chorus, *L'amour triomphe*, &c.: in this passage of the chorus, the two parts of the vocal and instrumental bass gives the principal sound and its octave; the first part above, or treble, and that of the counter-tenor, produce the seventeenth major, and its octave, in descending; and in short, the second part, or tenor above, gives the twelfth.

Theory of Harmony.

are in ſearch ſhall be a ſemitone beneath the natural *mi*, and of conſequence *mi* ♭.

30. This new arrangement, *ut*, *mi* ♭, *ſol*, in which the ſounds *ut* and *mi* ♭ have both the power of cauſing *ſol* to reſound, though *ut* does not cauſe *mi* ♭ to reſound, is not indeed equally perfect with the firſt arrangement *ut*, *mi*, *ſol*; becauſe in this the two ſounds *mi* and *ſol* are both the one and the other generated by the principal ſound *ut*; whereas, in the other, the ſound *mi* ♭ is not generated by the ſound *ut*; but this arrangement *ut*, *mi* ♭, *ſol*, is likewiſe dictated by nature (art. 19.), though leſs immediately than the former; and accordingly experience evinces that the ear accommodates itſelf almoſt as well to the latter as to the former.

74 rigin of mode minor. See Mode. See ſo Interval.

31. In this modulation or chord *ut*, *mi* ♭, *ſol*, *ut*, it is evident that the third from *ut* to *mi* ♭ is minor; and ſuch is the origin of that mode which we call *minor* (F).

75 erfect hords, hat.

32. The moſt perfect chords then are, 1. All chords related one to another, as *ut*, *mi*, *ſol*, *ut*, conſiſting of any ſound of its third major, of its fifth, and of its octave. 2. All chords related one to another, as *ut*, *mi* ♭, *ſol*, *ut*, conſiſting of any ſound, of its third minor, of its fifth, and of its octave. In effect, theſe two kinds of chords are exhibited by nature; but the firſt more immediately than the ſecond. The firſt are called *perfect chords major*, the ſecond *perfect chords minor*.

CHAP. III. *Of the Series which the Fifth requires, and of the Laws which it obſerves.*

76 unda-mental baſs hat.

33. SINCE the ſound *ut* cauſes the ſound *ſol* to be heard, and is itſelf heard in the ſound *fa*, which ſounds *ſol* and *fa* are its two-twelfths, we may imagine a modulation compoſed of that ſound *ut* and its two-twelfths, or, which is the ſame thing (art. 22.), of its two-fifths, *fa* and *ſol*, the one below, the other above; which gives the modulation or ſeries of fifths *fa*, *ut*, *ſol*, which I call the *fundamental baſs* of *ut* by fifths.

We ſhall find in the ſequel (Chap. XVIII.) that there may be ſome fundamental baſes by thirds, deduced from the two ſeventeenths, of which the one is an attendant of the principal ſound, and of which the other includes that ſound. But we muſt advance ſtep by ſtep, and ſatisfy ourſelves at preſent to conſider immediately the fundamental baſs by fifths.

34. Thus, from the ſound *ut*, one may make a tranſition indifferently to the ſound *ſol*, or to the ſound *fa*.

35. One may, for the ſame reaſon, continue this kind of fifths in aſcending, and in deſcending, from *ut*, in this manner:

mi ♭, *ſi* ♭, *fa*, *ut*, *ſol*, *re*, *la*, &c.

And from this ſeries of fifths one may paſs to any ſound which immediately precedes or follows it.

77 Exception to the rule.

36. But it is not allowed in the ſame manner to paſs from one ſound to another which is not immediately contiguous to it; for inſtance, from *ut* to *re*, or from *re* to *ut*: for this very ſimple reaſon, that the ſound *re* is not contained in the ſound *ut*, nor the ſound *ut* in that of *re*; and thus theſe ſounds have not any alliance the one with the other, which may authoriſe the tranſition from one to the other.

78 Two perfect chords in ſucceſſion proſcribed.

37. And as theſe ſounds *ut* and *re*, by the firſt experiment, naturally bring along with them the perfect chords conſiſting of greater intervals *ut*, *mi*, *ſol*, *ut*, *re*, *fa*※, *la*, *re*; hence may be deduced this rule, That two perfect chords, eſpecially if they are major (G), cannot ſucceed one another diatonically in a fundamental baſs; we mean, that in a fundamental baſs two ſounds cannot be diatonically placed in ſucceſſion, each of which, with its harmonics, forms a perfect chord, eſpecially if this perfect chord be major in both.

CHAP. IV. *Of Modes in general.*

79 Mode in general, what.

38. A *mode*, in muſic, is nothing elſe but the order of ſounds preſcribed, as well in harmony as melody, by the ſeries of fifths. Thus the three ſounds *fa*, *ut*, *ſol*, and the harmonics of each of theſe three ſounds, that is to ſay, their thirds major and their fifths, compoſe all the major modes which are proper to *ut*.

80 Modes, how repreſented by the ſeries of fifths.

39. The ſeries of fifths then, or the fundamental baſs *fa*, *ut*, *ſol*, of which *ut* holds the middle ſpace, may

(F) The origin which we have here given of the mode minor, is the moſt ſimple and natural that can poſſibly be given. In the firſt edition of this treatiſe, I had followed M. Rameau in deducing it from the following experiment.—If you put in vibration a muſical ſtring AB, and if there are at the ſame time contiguous to this two other ſtrings CF, LM, of which the firſt ſhall be a twelfth below the ſtring AB, and the ſecond LM a ſeventeenth major below the ſame AB, the ſtrings CF, LM, will vibrate without being ſtruck as ſoon as the ſtring AB ſhall give a ſound, and divide themſelves by a kind of undulation, the firſt into three, the laſt into five equal parts; in ſuch a manner, that, in the vibration of the ſtring CF, you may eaſily diſtinguiſh two points at reſt D, E, and in the tremulous motion of the ſtring LM four acquieſcent points N, O, P, Q, all placed at equal diſtances from each other, and dividing the ſtrings into three or five equal parts. In this experiment, ſays M. Rameau, if we repreſent by *ut* the tone of the ſtring AB, the two other ſtrings will repreſent the ſounds *fa* and *la* ♭; and from thence M. Rameau deduces the modulation *fa*, *la* ♭, *ut*, and of conſequence the mode minor. The origin which we have aſſigned to the minor mode in this new edition, appears to me more direct and more ſimple, becauſe it pre-ſuppoſes no other experiment than that of art. 19. and becauſe alſo the fundamental ſound *ut* is ſtill retained in both the modes, without being obliged, as M. Rameau found himſelf, to change it into *fa*. *See fig.* C.

(G) I ſay *eſpecially if they are major*; for in the major chord *re*, *fa*※, *la*, *re*, beſides that the ſounds *ut* and *re* have no common harmonical relation, and are even diſſonant between themſelves (Art. 18.), it will likewiſe be found, that *fa*※ forms a diſſonance with *ut*. The minor chord *re*, *fa*, *la*, *re*, would be more tolerable, becauſe the natural *fa* which occurs in this chord carries along with it its fifth *ut*, or rather the octave of that fifth: It has likewiſe been ſometimes the practice of compoſers, though rather by a licence indulged them than ſtrictly agreeable to their art, to place a minor in diatonic ſucceſſion to a major chord.

may be regarded as reprefenting the mode of *ut*. One may likewife take the feries of fifths, or fundamental bafe, *ut*, *fol*, *re*, as reprefenting the mode of *fol*; in the fame manner *fi*♭, *fa*, *ut*, will reprefent the mode of *fa*.

By this we may fee, that the mode of *fol*, or rather the fundamental bafs of that mode, has two founds in common with the fundamental bafs of the mode of *ut*. It is the fame with the fundamental bafs of the mode *fa*.

81 Principal mode, and adjuncts, what. See *Adjunct*.

40. The mode of *ut (fa, ut, fol,)* is called the *principal mode* with refpect to the modes of thefe two fifths, which are called its two *adjuncts*.

82 Modes relifhed in proportion as their founds are common.

41. It is then, in fome meafure, indifferent to the ear whether a tranfition be made to the one or to the other of thefe adjuncts, fince each of them has equally two founds in common with the principal mode. Yet the mode of *fol* feems a little more eligible: for *fol* is heard amongft the harmonics of *ut*, and of confequence is implied and fignified by *ut*; whereas *ut* does not caufe *fa* to be heard, though *ut* is included in the fame found *fa*. It is hence that the ear, affected by the mode of *ut*, is a little more prepoffeffed for the mode of *fol* than for that of *fa*. Nothing likewife is more frequent, nor more natural, than to pafs from the mode of *ut* to that of *fol*.

83 Dominant and fub-dominant, what. See *Dominant*.

42. It is for this reafon, as well as to diftinguifh the two fifths one from the other, that we call *fol* the fifth above the generator the *dominant* found, and the fifth *fa* beneath the generator the *fubdominant*.

84 Tranfition to contiguous founds, how to be managed.

43. It remains to add, as we have feen in the preceding chapter, that, in the feries of fifths, we may indifferently pafs from one found to that which is contiguous: In the fame manner, and for the fame reafon, one may pafs from the mode of *fol* to the mode of *re*, after having made a tranfition from the mode of *ut* to the mode of *fol*, as from the mode of *fa* to the mode of *fi* ♭. But it is neceffary, however, to obferve, that the ear which has been immediately affected with the principal mode feels always a ftrong propenfity to return to it. Thus the further the mode to which we make a tranfition is removed from the principal mode, the lefs time we ought to dwell upon it; or rather, to fpeak in the terms of the art, the lefs ought the phrafe (‡ *aa*) of that mode to be protracted.

CHAP. V. *Of the Formation of the Diatonic Scale as ufed by the Greeks.*

44. FROM this rule, that two founds which are contiguous may be placed in immediate fucceffion in the feries of fifths, *fa*, *ut*, *fol*, it follows, that one may form this modulation, or this fundamental bafs, by fifths, *fol*, *ut*, *fol*, *ut*, *fa*, *ut*, *fa*.

See fig. D.

85 Formation of the Greek diatonic fcale by the fundamental bafs.

45. Each of the founds which forms this modulation brings neceffarily along with itfelf its third major, its fifth, and its octave; infomuch that he who, for inftance, fings the note *fol* may be reckoned to fing at the fame time the notes *fol*, *fi*, *re*, *fol*: in the fame manner the found *ut* in the fundamental bafs brings along with it this modulation, *ut*, *mi*, *fol*, *ut*; and, in fhort, the fame found *fa* brings along with it *fa*, *la*, *ut*, *fa*. This modulation then, or this fundamental bafs,

fol, *ut*, *fol*, *ut*, *fa*, *ut*, *fa*,

gives the following diatonic feries,

fi, *ut*, *re*, *mi*, *fa*, *fol*, *la*.

which is precifely the diatonic fcale of the Greeks. We are ignorant upon what principles they had formed this fcale; but it may be fenfibly perceived, that that feries arifes from the bafs *fol*, *ut*, *fol*, *ut*, *fa*, *ut*, *fa*; and that of confequence this bafs is juftly called *fundamental*, as being the real primitive modulation, that which conducts the ear, and which it feels to be implied in the diatonic modulation *fi*, *ut*, *re*, *mi*, *fa*, *fol*, *la*, (H). See D.

46. We fhall be ftill more convinced of this truth by the following remarks.

In the modulation *fi*, *ut*, *re*, *mi*, *fa*, *fol*, *la*, the founds

(‡ *aa*) As the mere Englifh reader, unacquainted with the technical phrafeology of mufic, may be furprifed at the ufe of the word *phrafe* when transferred from language to that art, we have thought proper to infert the definition of Rouffeau.

A *phrafe*, according to him, is in melody a feries of modulations, or in harmony a fucceffion of chords, which form without interruption a fenfe more or lefs complete, and which terminate in a repofe by a cadence more or lefs perfect.

(H) Nothing is eafier than to find in this fcale the value or proportions of each found with relation to the found *ut*, which we call 1; for the two founds *fol* and *fa* in the bafs are $\frac{3}{2}$ and $\frac{2}{3}$; from whence it follows,

1. That *ut* in the fcale is the octave of *ut* in the bafs; that is to fay, 2.
2. That *fi* is the third major of *fol*; that is to fay $\frac{5}{4}$ of $\frac{3}{2}$ (note C), and of confequence $\frac{15}{8}$.
3. That *re* is the fifth of *fol*; that is to fay $\frac{3}{2}$ of $\frac{3}{2}$, and of confequence $\frac{9}{4}$.
4. That *mi* is the third major of the octave of *ut*, and of confequence the double of $\frac{5}{4}$; that is to fay, $\frac{5}{2}$.
5. That *fa* is the double octave of *fa* of the bafs, and confequently $\frac{8}{3}$.
6. That *fol* of the fcale is the octave of *fol* of the bafs, and confequently 3.
7. In fhort, that *la* in the fcale is the third major of *fa* of the fcale; that is to fay, $\frac{5}{4}$ of $\frac{8}{3}$, or $\frac{10}{3}$.

Hence then will refult the following table, in which each found has its numerical value above or below it.

Diatonic Scale.	$\frac{15}{8}$	2	$\frac{9}{4}$	$\frac{5}{2}$	$\frac{8}{3}$	3	$\frac{10}{3}$
	fi,	*ut*,	*re*,	*mi*,	*fa*,	*fol*,	*la*.
Fundamental Bafs.	*fol*,	*ut*,	*fol*,	*ut*,	*fa*,	*ut*,	*fa*.
	$\frac{3}{2}$	1,	$\frac{3}{2}$	1	$\frac{2}{3}$	1	$\frac{2}{3}$

And if, for the conveniency of calculation, we choofe to call the found *ut*, of the fcale 1; in this cafe there is nothing to do but to divide each of the numbers by 2, which reprefent the diatonic fcale, and we fhall have

$\frac{15}{16}$	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$
fi,	*ut*,	*re*,	*mi*,	*fa*,	*fol*,	*la*.

Theory of Harmony.

ſounds *re* and *fa* form between themſelves a third minor, which is not ſo perfectly true as that between *mi* and *ſol* (1). Nevertheleſs this alteration in the third minor between *re* and *fa* gives the ear no pain, becauſe that *re* and that *fa*, which do not form between themſelves a true third minor, form, each in particular, conſonances perfectly juſt with the ſounds in the fundamental baſs which correſpond with them: for *re* in the ſcale is the true fifth of *ſol*, which anſwers to it in the fundamental baſs; and *fa* in the ſcale is the true octave of *fa*, which anſwers to it in the ſame baſs.

85 Altered intervals, no objection.

47. If, therefore, theſe ſounds in the ſcale form conſonances perfectly true with the notes which correſpond to them in the fundamental baſs, the ear gives itſelf little trouble to inveſtigate the alterations which there may be in the intervals which theſe ſounds in the ſcale form between themſelves. This is a new proof that the fundamental baſs is the genuine guide of the ear, and the true origin of the diatonic ſcale.

86 Reaſons why this ſcale includes only ſeven ſounds.

48. Moreover, this diatonic ſcale includes only ſeven ſounds, and goes no higher than *ſi*, which would be the octave of the firſt: a new ſingularity, for which a reaſon may be given by the principles above eſtabliſhed. In reality, in order that the ſound *ſi* may ſucceed immediately in the ſcale to the ſound *la*, it is neceſſary that the note *ſol*, which is the only one from whence *ſi* as a harmonic may be deduced, ſhould immediately ſucceed to the ſound *fa*, in the fundamental baſs, which is the only one from whence *la* can be harmonically deduced. Now, the diatonic ſucceſſion from *fa* to *ſol* cannot be admitted in the fundamental baſs, according to what we have remarked (art. 36.) The ſounds *la* and *ſi*, then, cannot immediately ſucceed one another in the ſcale: we ſhall ſee in the ſequel why this is not the caſe in the ſeries *ut, re, mi, fa, ſol, la, ſi, UT*, which begins upon *ut*; whereas the ſcale in queſtion here begins upon *ſi*.

87 Completion of the Greek octave.

49. The Greeks likewiſe, to form an entire octave, added below the firſt *ſi* the note *la*, which they diſtinguiſhed and ſeparated from the reſt of the ſcale, and which for that reaſon they called *proſlambanomene*, that is to ſay, a ſtring or note ſubadded to the ſcale, and put before *ſi* to form the entire octave.

Theory of Harmony.

See Proſlambanomene.

88 The ſcale compoſed of two ſimilar conjunctive tetrachords.

50. The diatonic ſcale *ſi, ut, re, mi, fa, ſol, la*, is compoſed of two tetrachords, that is to ſay, of two diatonic ſcales, each conſiſting of four ſounds, *ſi, ut, re, mi*, and *mi, fa, ſol, la*. Theſe two tetrachords are exactly ſimilar; for from *mi* to *fa* there is the ſame interval as from *ſi* to *ut*; from *fa* to *ſol* the ſame as from *ut* to *re*, from *ſol* to *la* the ſame as from *re* to *mi* (L): this is the reaſon why the Greeks diſtinguiſhed theſe two tetrachords; yet they joined them by the note *mi*, which is common to both, and which gave them the name of *conjunctive tetrachords*.

89 Intervals in both tetrachords equal.

51. Moreover, the intervals between any two ſounds, taken in each tetrachord in particular, are preciſely true: thus, in the firſt tetrachord, the intervals of *ut mi*, and *ſi re*, are thirds, the one major and the other minor, exactly true, as well as the fourth *ſi mi* (M); it is the ſame thing with the tetrachord *mi, fa, ſol, la*, ſince this tetrachord is exactly like the former.

90 Intervals between the notes of different tetrachords diſſimilar.

52. But the caſe is not the ſame when we compare two ſounds taken each from a different tetrachord; for we have already ſeen, that the note *re* in the firſt tetrachord forms with the note *fa* in the ſecond a third minor, which is not true. In like manner it will be found, that the fifth from *re* to *la* is not exactly true, which is evident; for the third major from *fa* to *la* is true, and the third minor from *re* to *fa* is not ſo: now, in order to form a true fifth, a third major and a third minor, which are both exactly true, are neceſſary.

91 Another reaſon for diſtinguiſhing the ſcale into two tetrachords.

53. From thence it follows, that every conſonance is abſolutely perfect in each tetrachord taken by itſelf; but that there is ſome alteration in paſſing from one tetrachord to the other. This is a new reaſon for diſtinguiſhing the ſcale into theſe two tetrachords.

92 The ſource of tones major and minor inveſtigated.

54. It may be aſcertained by calculation, that in the tetrachord *ſi, ut, re, mi*, the interval, or the tone from

[d]

(1) In order to compare *re* with *fa*, we need only compare $\frac{9}{8}$ with $\frac{4}{3}$; the relation between theſe fractions will be (Note C), that of 9 times 3 to 8 times 4; that is to ſay, of 27 to 32: the third minor, then, from *re* to *fa*, is not true; becauſe the proportion of 27 to 32 is not the ſame with that of 5 to 6, theſe two proportions being between themſelves as 27 times 6 is to 32 times 5, that is to ſay, as 162 to 160, or as the halves of theſe two numbers, that is to ſay, as 81 to 80.

M. Rameau, when he publiſhed, in 1726, his *New theoretical and practical Syſtem of Muſic*, had not as yet found the true reaſon of the alteration in the conſonance which is between *re* and *fa*, and of the little attention which the ear pays to it. For he pretends, in the work now quoted, that there are two thirds minor, one in the proportion of 5 to 6, the other in the proportion of 27 to 32. But the opinion which he has afterwards adopted, ſeems much preferable. In reality, the genuine third minor, is that which is produced by nature between *mi* and *ſol*, in the continued tone of thoſe ſonorous bodies, of which *mi* and *ſol* are the two harmonics; and that third minor, which is in the proportion of 5 to 6, is likewiſe that which takes place in the minor mode, and not that third minor which is falſe and different, being in the proportion of 27 to 32.

(L) The proportion of *ſi* to *ut* is as $\frac{15}{16}$ to 1, that is to ſay as 15 to 16; that between *mi* and *fa* is as $\frac{5}{4}$ to $\frac{4}{3}$ that is to ſay (note C) as 5 times 3 to 4 times 4, or as 15 to 16: theſe two proportions then are equal. In the ſame manner, the proportion of *ut* to *re* is as 1 to $\frac{9}{8}$, or as 8 to 9; that between *fa* and *ſol* is as $\frac{4}{3}$ to $\frac{3}{2}$; that is to ſay (note C), as 8 to 9. The proportion of *mi* to *ut* is as $\frac{5}{4}$ to 1, or as 5 to 4; that between *fa* and *la* is as $\frac{5}{3}$ to $\frac{4}{3}$, or as 5 to 4: the proportions here then are likewiſe equal.

(M) The proportion of *mi* to *ut* is as $\frac{5}{4}$ to 1, or as 5 to 4, which is a true third major; that from *re* to *ſi* is as $\frac{9}{8}$ to $\frac{15}{16}$; that is to ſay, as 9 times 16 to 15 times 8, or as 9 times 2 to 15, or as 6 to 5. In like manner, we ſhall find, that the proportion of *mi* to *ſi* is as $\frac{5}{4}$ to $\frac{15}{16}$; that is to ſay, as 5 times 16 to 15 times 4, or as 4 to 3, which is a true fourth.

2

Theory of Harmony.

from *re* to *mi*, is a little leſs than the interval or tone from *ut* to *re* (N). In the ſame manner, in the ſecond tetrachord *mi, fa, ſol, la,* which is, as we have proved, perfectly ſimilar to the firſt, the note from *ſol* to *la* is a little leſs than the note from *fa* to *ſol*. It is for this reaſon that they diſtinguiſh two kinds of tones; the greater tone *, as from *ut* to *re*, from *fa* to *ſol*, &c.; and the leſſer †, as from *re* to *mi*, from *ſol* to *la*, &c.

* Greater tone. See *Interval*.
† Leſſer tone. See *Interval*.

Chap. VI. *The formation of the Diatonic Scale among the Moderns, or the ordinary Gammut.*

93
The modern ſcale, how formed.

55. We have juſt ſhown in the preceding chapter, how the ſcale of the Greeks is formed, *ſi, ut, re, mi, fa, ſol, la,* by means of a fundamental baſs compoſed of three ſounds only, *fa, ut, ſol*: but to form the ſcale *ut, re, mi, fa, ſol, la, ſi, UT,* which we uſe at preſent, we muſt neceſſarily add to the fundamental baſs the note *re*, and form, with theſe four ſounds *fa, ut, ſol, re,* the following fundamental baſs:

See fig. E. *ut, ſol, ut, fa, ut, ſol, re, ſol, ut;*

See *Scale*. from whence we deduce the modulation or ſcale.

ut, re, mi, fa, ſol, la, ſi, UT.

In effect (O), *ut* in the ſcale belongs to the harmony of *ut* which correſponds with it in the baſs; *re*, which is the ſecond note in the gammut, is included in the harmony of *ſol*, the ſecond note of the baſs; *mi*, the third note of the gammut, is a natural harmonic of *ut*, which is the third ſound in the baſs, &c.

94
The Greek diatonic ſcale ſimpler than ours, and why.

56. From thence it follows, that the diatonic ſcale of the Greeks is, at leaſt in ſome reſpects, more ſimple than ours; ſince the ſcale of the Greeks (chap. v.) may be formed alone from the mode proper to *ut*; whereas ours is originally and primitively formed, not only from the mode of *ut* (*fa, ut, ſol*), but likewiſe from the mode of *ſol*, (*ut, ſol, re*.)

It will likewiſe appear, that this laſt ſcale conſiſts of two parts; of which the one, *ut, re, mi, fa, ſol,* is in the mode of *ut*; and the other, *ſol, la, ſi, ut,* in that of *ſol*.

95
The note *ſol* twice repeated in the diatonic ſcale from its harmonic relations to the fundamental baſs.

57. It is for this reaſon that the note *ſol* is found to be twice repeated in immediate ſucceſſion in this ſcale; once as the fifth of *ut*, which correſponds with it in the fundamental baſs; and again, as the octave of *ſol*, which immediately follows *ut* in the ſame baſs. As to what remains, theſe two conſecutive *ſol's* are otherwiſe in perfect uniſon. It is for this reaſon that we are ſatisfied with ſinging only one of them when one modulates the ſcale *ut, re, mi, fa, ſol, la, ſi, UT*: but this does not prevent us from employing a pauſe or repoſe, expreſſed or underſtood, after the ſound *fa*. There is no perſon who does not perceive this whilſt he himſelf ſings the ſcale. 96

The modern ſcale compoſed of two disjunctive tetrachords of different modes.

58. The ſcale of the moderns, then, may be conſidered as conſiſting of two tetrachords, disjunctive indeed, but perfectly ſimilar one to the other, *ut, re, mi, fa,* and *ſol, la, ſi, ut,* one in the mode of *ut*, the other in that of *ſol*. For what remains, we ſhall ſee in the ſequel by what artifice one may cauſe the ſcale *ut, re, mi, fa, ſol, la, ſi, UT,* to be regarded as belonging to the mode of *ut* alone. For this purpoſe it is neceſſary to make ſome changes in the fundamental baſs, which we have already aſſigned: but this ſhall be explained at large in chap. xiii. 67

The mode of *ſol* introduced in the fundamental baſs productive of conveniences.

59. The introduction of the mode proper to *ſol* in the fundamental baſs has this happy effect, that the notes *fa, ſol, la, ſi,* may immediately ſucceed each other in aſcending the ſcale, which cannot take place (art. 48.) in the diatonic ſeries of the Greeks, becauſe that ſeries is formed from the mode of *ut* alone. From whence it follows:

1. That we change the mode at every time when we modulate three notes in ſucceſſion.

2. That if theſe three notes are ſung in ſucceſſion in the ſcale *ut, re, mi, fa, ſol, la, ſi, UT,* this cannot be done but by the aſſiſtance of a pauſe expreſſed or underſtood after the note *fa*; inſomuch, that the three tones *fa, ſol, la, ſi,* (three only becauſe the note *ſol* which is repeated is not enumerated) are ſuppoſed to belong to two different tetrachords. 98

Change of mode the cauſe of the difficulty in ſinging three conſecutive tones aſcending.

60. It ought not then any longer to ſurpriſe us, that we feel ſome difficulty whilſt we aſcend the ſcale in ſinging three tones in ſucceſſion, becauſe this is impracticable without changing the mode; and if one pauſes in the ſame mode, the fourth ſound above the firſt note will never be higher than a ſemitone above that which immediately precedes it; as may be ſeen by *ut, re, mi, fa,* and by *ſol, la, ſi, ut,* where there is no more than a ſemitone between *mi* and *fa*, and between *ſi* and *ut*.

61. We

(N) The proportion of *re* to *ut* is as $\frac{9}{8}$ to 1, or as 9 to 8; that of *mi* to *re* is as $\frac{5}{4}$ to $\frac{9}{8}$, that is to ſay, as 40 to 36, or as 10 to 9: now $\frac{10}{9}$ is leſs removed from unity than $\frac{9}{8}$; the interval then from *re* to *mi* is a little leſs than that from *ut* to *re*.

If any one would wiſh to know the proportion which $\frac{10}{9}$ bear to $\frac{9}{8}$, he will find (note C), that it is as 8 times 10 to 9 times 9, that is to ſay, as 80 to 81. Thus the proportion of a minor to a major tone is as 80 to 81; this difference between the major and minor tone, is what the Greeks called a *comma*. Though real, it is imperceptible to the ear.

We may remark, that this difference of a comma is found between the third minor when true and harmonical, and the ſame chord when it ſuffers alteration *re fa*, of which we have taken notice in the ſcale (note I); for we have ſeen, that this third minor thus altered is in the proportion of 80 to 81 with the true third minor.

(O) The values or eſtimates of the notes ſhall be the ſame in this as in the former ſcale, excepting only the tone *la*; for *re* being repreſented by $\frac{9}{8}$, its fifth ſhall be expreſſed by $\frac{27}{16}$; ſo that the ſcale will be numerically ſignified thus:

1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{27}{16}$	$\frac{15}{8}$	2
ut,	*re,*	*mi,*	*fa,*	*ſol,*	*la,*	*ſi,*	*UT.*

Where you may ſee, that the note *la* of this ſcale is different from that in the ſcale of the Greeks; and that the *la* in the modern ſeries ſtands in proportion to that of the Greeks as $\frac{27}{16}$ to $\frac{5}{3}$, that is to ſay, as 81 to 80; theſe two *la's* then likewiſe differ by a *comma*.

Theory of Harmony.

99 Intervals, though altered in themſelves, form true conſonances with the fundamental baſs.

61. We may likewiſe obſerve in the ſcale *ut, re, mi, fa*, that the third minor from *re* to *fa* is not true, for the reaſons which have been already given (art 49.) It is the ſame caſe with the third minor from *la* to *ut*, and with the third major from *fa* to *la*: but each of theſe ſounds form otherwiſe conſonances perfectly true, with their correſpondent ſounds in the fundamental baſs.

62. The thirds *la ut, fa la*, which were true in the former ſcale, are falſe in this; becauſe in the former ſcale *la* was the third of *fa*, and here it is the fifth of *re*, which correſponds with it in the fundamental baſs.

100 Fewer altered conſonances in the Greek ſcale than in ours.

63. Thus it appears, that the ſcale of the Greeks contains fewer conſonances that are altered than ours (P); and this likewiſe happens from the introduction of the mode of *ſol* into the fundamental baſs (Q).

We ſee likewiſe that the value of *la* in the diatonic ſcale, a value which authors have been divided in aſcertaining, ſolely depends upon the fundamental baſs, and that it muſt be different according as the note *la* has *fa* or *re* for its baſs. See the note (O).

Chap. VII. *Of Temperament.*

101 Temperament, why neceſſary.

64. The alterations which we have obſerved in the intervals between particular ſounds of the diatonic ſcale, naturally lead us to ſpeak of temperament. To give a clear idea of this, and to render the neceſſity of it palpable, let us ſuppoſe that we have before us an inſtrument with keys, a harpſichord, for inſtance, conſiſting of ſeveral octaves or ſcales, of which each includes its twelve ſemitones.

Let us chooſe in that harpſichord one of the ſtrings which will ſound the note UT, and let us tune the ſtring SOL to a perfect fifth with UT in aſcending; let us afterwards tune to a perfect fifth with this SOL the RE which is above it; we ſhall evidently perceive that this RE will be in the ſcale above that from which we ſet out: but it is alſo evident that this RE muſt have in the ſcale a *re* which correſponds with it, and which muſt be tuned a true octave below RE; and between this and SOL there ſhould be the interval of a fifth; ſo that the *re* in the firſt ſcale will be a true fourth below the SOL of the ſame ſcale. We may afterwards tune the note LA of the firſt ſcale to a juſt fifth with this laſt *re*; then the note MI in the higheſt ſcale to a true fifth with this new LA, and of conſequence the *mi* in the firſt ſcale to a true fourth beneath this ſame LA: Having finiſhed this operation, it will be found that the laſt *mi*, thus tuned, will by no means form a juſt third major from the ſound UT (R): that is to ſay, that it is impoſſible for *mi* to conſtitute at the ſame time the third major of UT, and the true fifth of LA; or, what is the ſame thing, the true fourth of LA in deſcending.

See fig. F.

Theory of Harmony.

65. What is ſtill more, if, after having ſucceſſively and alternately tuned the ſtrings UT, SOL, *re*, LA, *mi*, in perfect fifths and fourths one from the other, we continue to tune ſucceſſively by true fifths and fourths the ſtrings *mi, ſi, fa*※, *ut*※, *ſol*※, *re*※, *mi*※, *ſi*※; we ſhall find, that, though *ſi*※, being a ſemitone higher than the natural note, ſhould be equivalent to UT natural, it will by no means form a juſt octave to the firſt *ut* in the ſcale, but be conſiderably higher (S); yet

(d 2)

(P) In the ſcale of the Greeks, the note *la* being a third from *fa*, there is an altered fifth between *la* and *re*: but in ours, *la* being a fifth to *re*, produces two altered thirds, *fa la*, and *la ut*; and likewiſe a fifth altered, *la mi*, as we ſhall ſee in the following chapter. Thus there are in our ſcale two intervals more than in the ſcale of the Greeks which ſuffer alteration.

(Q) But here it may be with ſome colour objected. The ſcale of the Greeks, it may be ſaid, has a fundamental baſs more ſimple than ours; and beſides, in it there are fewer chords which will not be found exactly true: why then, notwithſtanding this, does ours appear more eaſy to be ſung than that of the Greeks? The Grecian ſcale begins with a ſemitone, whereas the intonation prompted by nature ſeems to impel us to riſe by a full tone at once. This objection may be thus anſwered. The ſcale of the Greeks is indeed better diſpoſed than ours for the ſimplicity of the baſs, but the arrangement of ours is more ſuitable to natural intonation. Our ſcale commences by the fundamental ſound *ut*, and it is in reality from that ſound that we ought to begin; it is from this that all the others naturally ariſe, and upon this that they depend; nay, if I may ſpeak ſo, in this they are included: on the contrary, neither the ſcale of the Greeks, nor its fundamental baſs, commences with *ut*; but it is from this *ut* that we muſt depart, in order to regulate our intonation, whether in riſing or deſcending: now, in aſcending from *ut*, the intonation, even of the Greek ſcale, gives the ſeries *ut, re, mi, fa, ſol, la*: and ſo true is it that the fundamental ſound *ut* is here the genuine guide of the ear, that if, before we modulate the ſound *ut*, we ſhould attempt to riſe to it by that note in the ſcale which is moſt immediately contiguous, we cannot reach it but by the note *ſi*; and by the ſemitone from *ſi* to *ut*. Now to make a tranſition from *ſi* to *ut* by this ſemitone, the ear muſt of neceſſity be prediſpoſed for that modulation, and conſequently preoccupied with the mode of *ut*: if this were not the caſe, we ſhould naturally riſe from *ſi* to *ut*※, and by this operation paſs into another mode.

(R) The LA conſidered as the fifth of *re* is $\frac{27}{16}$, and the fourth beneath this LA will conſtitute $\frac{3}{4}$ of $\frac{27}{16}$, that is to ſay, $\frac{81}{64}$; $\frac{81}{64}$ then ſhall be the value of *mi*, conſidered as a true fourth from LA in deſcending: now *mi*, conſidered as the third major of the ſound UT, is $\frac{5}{3}$, or $\frac{80}{64}$: theſe two *mi*'s then are between themſelves in the proportion of 81 to 80; thus it is impoſſible that *mi* ſhould be at the ſame time a perfect third major from UT, and a true fourth beneath LA.

(S) In effect, if you thus alternately tune the fifth above, and the fourth below, in the ſame octave, you may here ſee what will be the proceſs of your operation.

UT, SOL, a fifth; *re* a fourth; LA a fifth; *mi* a fourth; *ſi* a fifth; *fa*※ a fourth; *ut*※ a fifth; *ſol*※ a fourth; RE※ a fifth; *la*※ a fourth; MI※ or FA a fifth; *ſi*※ a fourth: now it will be found, by a very eaſy computation, that the firſt UT being repreſented by 1, SOL ſhall be $\frac{3}{2}$, *re* $\frac{9}{8}$, LA $\frac{27}{16}$, *mi* $\frac{81}{64}$, &c. and ſo of the

yet this *fi*※ upon the harpsichord ought not to be different from the octave above UT; for every *fi*※ and every UT is the same sound, since the octave or the scale only consists of twelve semitones.

102
Reasons and rules for temperament.

66. From thence it necessarily follows, 1. That it is impossible that all the octaves and all the fifths should be just at the same time, particularly in instruments which have keys, where no intervals less than a semitone are admitted. 2. That, of consequence, if the fifths are justly tuned, some alteration must be made in the octaves; now the sympathy of sound which subsists between any note and its octave, does not permit us to make such an alteration: this perfect coalescence of sound is the cause why the octave should serve as limits to the other intervals, and that all the notes which rise above or fall below the ordinary scale, are no more than replications, *i. e.* repetitions, of all that have gone before them. For this reason, if the octave were altered, there could be no longer any fixed point either in harmony or melody. It is then absolutely necessary to tune the *ut* or *fi*※ in a just octave with the first; from whence it follows, that, in the progression of fifths, or, what is the same thing, in the alternate series of fifths and fourths, UT, SOL, *re*, LA, *mi*, *si*, *fa*※, *ut*※, *sol*※, *re*※, *la*※, *mi*※, *fi*※, it is necessary that all the fifths should be altered, or at least some of them. Now, since there is no reason why one should rather be altered than another, it follows, that we ought to alter them all equally. By these means, as the alteration is made to influence all the fifths, it will be in each of them almost imperceptible; and thus the fifth, which, after the octave, is the most perfect of all consonances, and which we are under a necessity of altering, must only be altered in the least degree possible.

67. It is true, that the thirds will be a little harsh: but as the interval of sounds which constitutes the third, produces a less perfect coalescence than that of the fifth, it is necessary, says M. Rameau, to sacrifice the justice of that chord to the perfection of the fifth; for the more perfect a chord is in its own nature, the more displeasing to the ear is any alteration which can be made in it. In the octave the least alteration is insupportable.

68. This change in the intervals of instruments which have, or even which have not, keys, is that which we call *temperament*. 103
Its definition.

69. It results then from all that we have now said, that the theory of temperament may be reduced to this question.—The alternate succession of fifths and fourths having been given, UT, SOL, *re*, LA, *mi*, *si*, *fa*※, *ut*※, *sol*※, *re*※, *la*※, *mi*※, *fi*※, in which *fi*※ or *ut* is not the true octave of the first UT, it is proposed to alter all the fifths equally, in such a manner that the two *ut's* may be in a perfect octave the one to the other. 104
Principle whence its theory may be deduced.

70. For a solution of this question, we must begin with tuning the two *ut*'s in a perfect octave the one to the other; in consequence of which, we will render all the semitones which compose the octave as equal as possible. By this means (T) the alteration made in each fifth will be very inconsiderable, but equal in all of 105
Practical directions for temperament.

the rest till you arrive at *fi*※, which will be found $\frac{531441}{262144}$. This fraction is evidently greater than the number 2, which expresses the perfect octave *ut* to its correspondent UT; and the octave below *fi*※ would be one half of the same fraction, that is to say $\frac{531441}{524288}$, which is evidently greater than UT represented by unity. This last fraction $\frac{531441}{524288}$ is composed of two numbers; the numerator of the fraction is nothing else but the number 3 multiplied 11 times in succession by itself, and the denominator is the number 2 multiplied 18 times in succession by itself.. Now it is evident, that this fraction, which expresses the value of *fi*※, is not equal to the unity which expresses the value of the sound UT; though, upon the harpsichord, *fi*※ and UT are identical. This fraction rises above unity by $\frac{7153}{524288}$, that is to say, by about $\frac{1}{73}$; and this difference was called the *comma of Pythagoras*. It is palpable that this comma is much more considerable than that which we have already mentioned, note (N), and which is only $\frac{1}{85}$.

We have already proved that the series of fifths produces an *ut* different from *fi*※, the series of thirds major gives another still more different. For, let us suppose this series of thirds, *ut*, *mi*, *sol*※, *fi*※, we shall have *mi* equal to $\frac{5}{4}$, *sol*※ to $\frac{25}{16}$, and *fi*※ to $\frac{125}{64}$, whose octave below is $\frac{125}{128}$; from whence it appears, that this last *fi* is less than unity (that is to say, than *ut*), by $\frac{3}{128}$, or by $\frac{1}{42}$, or near it: A new comma, much greater than the preceding, and which the Greeks have called *apotome major*.

It may be observed, that this *fi*※, deduced from the series of thirds, is to the *fi*※ deduced from the series of fifths, as $\frac{125}{128}$ is to $\frac{531441}{524288}$; that is to say, in multiplying by 524288, as 125 multiplied by 4096 is to 531441, or as 512000 to 531441, that is to say, nearly as 26 is to 27: from whence it may be seen, that these two *fi*'s※ are very considerably different one from the other, and even sufficiently different to make the ear sensible of it; because the difference consists almost of a minor semitone, whose value, as will afterwards be seen (art. 139.), is $\frac{25}{24}$.

Moreover, if, after having found the *sol*※ equal to $\frac{25}{16}$, we then tune by fifths and by fourths, *sol*※, *re*※, *la*※, *mi*※, *fi*※, as we have done with respect to the first series of fifths, we find that the *fi*※ must be $\frac{2025}{2048}$; its difference, then, from unity, or, in other words, from UT, is $\frac{23}{2048}$, that is to say, about $\frac{1}{89}$; a comma still less than any of the preceding, and which the Greeks have called *apotome minor*.

In a word, if, after having found *mi* equal to $\frac{5}{4}$ in the progression of thirds, we then tune by fifths and fourths *mi*, *si*, *fa*※, *ut*※, &c. we shall arrive at a new *fi*※, which shall be $\frac{32805}{32768}$, and which will not differ from unity but by about $\frac{1}{885}$, which is the last and smallest of all the commas; but it must be observed, that, in this case, the thirds major from *mi* to *sol*※, from *sol*※ to *fi*※ or *ut*, &c. are extremely false, and greatly altered.

(T) All the semitones being equal in the temperament proposed by M. Rameau, it follows, that the twelve semitones *ut*, *ut*※, *re*, *re*※, *mi*, *mi*※, &c. shall form a continued geometrical progression; that is to say, a series in which *ut* shall be to *ut*※ in the same proportion as *ut*※ to *re*, as *re* to *re*※, &c. and so of the rest.

These

of them.

71. In this, then, the theory of temperament consists: but as it would be difficult in practice to tune a harpsichord or organ by thus rendering all the semitones equal, M. Rameau, in his *Generation Harmonique*, has furnished us with the following method, to alter all the fifths as equally as possible.

106 Rameau's method of temperament proposed.

72. Take any key of the harpsichord which you please, but let it be towards the middle of the instrument; for instance, UT: then tune the note SOL a fifth above it, at first with as much accuracy as possible; this you may imperceptibly diminish: tune afterwards the fifth to this with equal accuracy, and diminish it in the same manner; and thus proceed from one fifth to another in ascent: and as the ear does not appretiate so exactly sounds that are extremely sharp, it is necessary, when by fifths you have risen to notes extremely high, that you should tune in the most perfect manner the octave below the last fifth which you had immediately formed; then you may continue always in the same manner; till in this process you arrive at the last fifth from *mi*※ to *si*※, which should of themselves be in tune; that is to say, they ought to be in such a state, that *si*※, the highest note of the two which compose the fifth, may be identical with the sound UT, with which you began, or at least the octave of that sound perfectly just: it will be necessary then to try if this UT, or its octave, forms a just fifth with the last found *mi*※ or *fa* which has been already tuned. If this be the case, we may be certain that the harpsichord is properly tuned. But if this last fifth be not true, in this case it will be too sharp, and it is an indication that the other fifths have been too much diminished, or at least some of them; or it will be too flat, and consequently discover that they have not been sufficiently diminished. We must then begin and proceed as formerly, till we find the last fifth in tune of itself, and without our immediate interposition (*v*).

By

These twelve semitones are formed by a series of thirteen sounds, of which *UT* and its octave *ut* are the first and last. Thus to find by computation the value of each sound in the temperament, which is the present object of our speculations, our scrutiny is limited to the investigation of eleven other numbers between 1 and 2 which may form with the 1 and the 2 a continued geometrical progression.

However little any one is practised in calculation, he will easily find each of these numbers, or at least a number approaching to its value. These are the characters by which they may be expressed, which mathematicians will easily understand, and which others may neglect.

UT	*ut*※	*re*	*re*※	*mi*	*fa*	*fa*※	*sol*	*sol*※
1	$\sqrt[12]{2}$	$\sqrt[12]{2^2}$	$\sqrt[12]{2^3}$	$\sqrt[12]{2^4}$	$\sqrt[12]{2^5}$	$\sqrt[12]{2^6}$	$\sqrt[12]{2^7}$	$\sqrt[12]{2^8}$
	la	*la*※	*si*	*ut*				
	$\sqrt[12]{2^9}$	$\sqrt[12]{2^{10}}$	$\sqrt[12]{{}^{11}}$	$\sqrt[12]{{}^{12}}$				

It is obvious, that in this temperament all the fifths are equally altered. One may likewise prove, that the alteration of each in particular is very inconsiderable; for it will be found, for instance, that the fifth from *ut* to *sol*, which should be $\frac{3}{2}$, ought to be diminished by about $\frac{1}{12}$ of $\frac{1}{73}$; that is to say, by $\frac{1}{876}$, a quantity almost inconceivably small.

It is true, that the thirds major will be a little more altered; for the third major from *ut* to *mi*, for instance, shall be increased in its interval by about $\frac{1}{100}$: but it is better, according to M. Rameau, that the alteration should fall upon the third than upon the fifth, which after the octave is the most perfect chord, and from the perfection of which we ought never to degenerate but as little as possible.

Besides, it has appeared from the series of thirds major *ut*, *mi*, *sol* ※, *si*※, that this last *si*※ is very different from *ut* (note s); from whence it follows, that if we would tune this *si*※ in unison with the octave of *ut*, and alter at the same time each of the thirds major by a degree as small as possible, they must all be equally altered. This is what occurred in the temperament which we propose; and if in it the third be more altered than the fifth, it is a consequence of the difference which we find between the degrees of perfection in these intervals; a difference, with which, if we may speak so, the temperament proposed conforms itself. Thus this diversity of alteration is rather advantageous than inconvenient.

(*v*) All that remains, is to acknowledge, with M. Rameau, that this temperament is far remote from that which is now in practice: you may here see in what this last temperament consists as applied to the organ or harpsichord. They begin with *UT* in the middle of the keys, and they flatten the four first fifths *sol*, *re*, *la*, *mi*, till they form a true third major from *mi* to *ut*; afterwards, setting out from this *mi*, they tune the fifths *si*, *fa*※, *ut*※, *sol*※, but flattening them still less than the former, so that *sol*※ may almost form a true third major with *mi*. When they have arrived at *sol*※, they stop; they resume the first *ut*, and tune to it the fifth *fa* in descending, then the fifth *si*♭, &c. and they heighten a little all the fifths till they have arrived at *la*♭, which ought to be the same with the *sol*※ already tuned.

If, in the temperament commonly practised, some thirds are found to be less altered than in that prescribed by M. Rameau, in return, the fifths in the first temperament are much more false, and many thirds are likewise so; insomuch, that upon a harpsichord tuned according to the temperament in common use, there are five or six modes which the ear cannot endure, and in which it is impossible to execute any thing. On the contrary, in the temperament suggested by M. Rameau, all the modes are equally perfect; which is a new argument in its favour, since the temperament is peculiarly necessary in passing from one mode to another, without shocking the ear; for instance, from the mode of *ut* to that of *sol*, from the mode of *sol* to that of *re*, &c. It is true, that this uniformity of modulation will to the greatest number of musicians appear a defect: for they imagine, that, by tuning the semitones of the scale unequal, they give each of the modes a peculiar character;

so

Theory of Harmony.

By this method all the twelve ſounds which compoſe one of the ſcales ſhall be tuned: nothing is neceſſary but to tune with the greateſt poſſible exactneſs their octaves in the other ſcales, and the harpſichord ſhall be well tuned.

107
Alterations by either method hardly diſagreeable.

We have given this rule for temperament, from M. Rameau; and it belongs only to diſintereſted artiſts to judge of it. However this queſtion be determined, and whatever kind of temperament may be received, the alterations which it produces in harmony will be but very ſmall, or not perceptible to the ear, whoſe attention is entirely engroſſed in attuning itſelf with the fundamental baſs, and which ſuffers, without uneaſineſs, theſe alterations, or rather takes no notice of them, becauſe it ſupplies from itſelf what may be wanting to the truth and perfection of the intervals.

Simple and daily experiments confirm what we now advance. Liſten to a voice which is accompanied, in ſinging, by different inſtruments; though the temperament of the voice, and the temperaments of each of the inſtruments, are all different one from another, yet you will not be in the leaſt affected with the kind of cacophony which ought to reſult from theſe diverſities, becauſe the ear ſuppoſes theſe intervals true of which it does not appreciate the differences.

We may give another experiment. Strike upon an organ the three keys *mi*, *ſol*, *ſi*, you will hear nothing but the minor perfect chord; tho' *mi*, by the conſtruction of that inſtrument, muſt cauſe *ſol*※ likewiſe to be heard; though *ſol* ſhould have the ſame effect upon *re*, and *ſi* upon *fa*※; inſomuch, that the ear is at once affected with all theſe ſounds, *re*, *mi*, *fa*※, *ſol*, *ſol*※, *ſi*: how many diſſonances perceived at the ſame time, and what a jarring multitude of diſcordant ſenſations, would reſult from thence to the ear, if the perfect chord with which it is preoccupied had not power entirely to abſtract its attention from ſuch ſounds as might offend!

CHAP.

ſo that, according to them, the ſcale of *ut*,

ut, *re*, *mi*, *fa*, *ſol*, *la*, *ſi*, *UT*,

is not perfectly ſimilar to the gammut or diatonic ſcale of the mode of *mi*

mi, *fa*※, *ſol*※, *la*※, *ſi*, *ut*※, *re*※, *mi*,

which, in their judgment, renders the modes of *ut* and *mi* proper for different manners of expreſſion. But after all that we have ſaid in this treatiſe on the formation of diatonic intervals, every one ſhould be convinced, that, according to the intention of nature, the diatonic ſcale ought to be perfectly the ſame in all its modes: The contrary opinion, ſays M. Rameau, is a mere prejudice of muſicians. The character of an air ariſes chiefly from the intermixture of the modes; from the greater or leſſer degrees of vivacity in the movement; from the tones, more or leſs grave, or more or leſs acute, which are aſſigned to the generator of the mode; and from the chords more or leſs beautiful, as they are more or leſs deep, more or leſs flat, more or leſs ſharp, which are found in it.

In ſhort, the laſt advantage of this temperament is, that it will be found conformed, or at leaſt very little different from that which they practiſe upon inſtruments without keys; as the baſs-viol, the violin, in which true fifths and fourths are preferred to thirds and ſixths tuned with equal accuracy; a temperament which appears incompatible with that commonly uſed in tuning the harpſichord.

Yet we muſt not ſuffer our readers to be ignorant, that M. Rameau, in his *New Syſtem of Muſic*, printed in 1726, had adopted the ordinary temperament. In that work, (as may be ſeen CHAP. XXIV.), he pretends that the alteration of the fifths is much more ſupportable than that of the thirds major; and that this laſt interval can hardly ſuffer a greater alteration than the octave, which, as we know, cannot ſuffer the ſlighteſt alteration. He ſays, that if three ſtrings are tuned, one by an octave, the other by a fifth, and the next by a third major to a fourth ſtring, and if a ſound be produced from the laſt, the ſtring tuned by a fifth will vibrate, though a little leſs true than it ought to have been; but that the octave and the third major, if altered in the leaſt degree, will not vibrate: and he adds, that the temperament which is now practiſed, is founded upon that principle. M. Rameau goes ſtill farther; and as, in the ordinary temperament, there is a neceſſity for altering the laſt thirds major, and to make them a little more ſharp, that they may naturally return to the octave of the principal ſound, he pretends that this alteration is tolerable, not only becauſe it is almoſt inſenſible, but becauſe it is found in modulations not much in uſe, unleſs the compoſer ſhould chooſe it on purpoſe to render the expreſſion ſtronger. "For it is proper to remark, (ſays he), that we receive different impreſſions from the intervals in proportion to their different alterations: for inſtance, the third major, which naturally elevates us to joy, in proportion as we feel it, heightens our feelings even to a kind of fury, when it is tuned too ſharp; and the third minor, which naturally inſpires us with tenderneſs and ſerenity, depreſſes us to melancholy when it is too flat." All this ſtrain, as you may ſee, is immenſely different from that which this celebrated muſician afterwards exhibited in his *Generation Harmonique*, and in the performances which followed it. From this we can only conclude, that the reaſons, which, after him, we have urged for the new temperament, muſt without doubt have appeared to him very ſtrong, becauſe in his mind they have ſuperſeded thoſe which he had formerly adduced in favour of the ordinary temperament.

We do not pretend to give any deciſion for either the one or the other of theſe methods of temperament, each of which appears to us to have its particular advantages. We ſhall only remark, that the choice of the one or the other muſt be left abſolutely to the taſte and inclination of the reader; without, however, admitting this choice to have any influence upon the principles of the ſyſtem of muſic, which we have followed even till this period, and which muſt always ſubſiſt, whatever temperament we adopt.

Chap. VIII. *Of Repoſes or Cadences* (†).

108 Cadences perfect and imperfect, what and why. See *Repoſe* or *Cadence.*

73. In a fundamental baſs whoſe procedure is by fifths, there always is, or always may be, a *repoſe*, or criſis, in which the mind acquieſces in its tranſition from one ſound to another: but a repoſe may be more or leſs diſtinctly ſignified, and of conſequence more or leſs perfect. If one ſhould riſe by fifths; if, for inſtance, we paſs from *ut* to *ſol*; it is the generator which paſſes to one of theſe fifths, and this fifth was already pre-exiſtent in its generator: but the generator exiſts no longer in this fifth; and the ear, as this generator is the principle of all harmony and of all melody, feels a deſire to return to it. Thus the tranſition from a ſound to its fifth in aſcent, is termed an *imperfect repoſe*, or *imperfect cadence*; but the tranſition from any ſound to its fifth in deſcent, is denominated a *perfect cadence*, or an *abſolute repoſe*: it is the offſpring which returns to its generator, and as it were recovers its exiſtence once more in that generator itſelf, with which when ſounding it reſounds (chap. i.)

109 Perfect cadences more or leſs perfect, and why.

74. Amongſt abſolute repoſes, there are ſome, if we may be allowed the expreſſion, more abſolute, that is to ſay, more perfect, than others. Thus in the fundamental baſs

ut, ſol, ut, fa, ut, ſol, re, ſol, ut,

which forms, as we have ſeen, the diatonic ſcale of the moderns, there is an abſolute repoſe from *re* to *ſol*, as from *ſol* to *ut*: yet this laſt abſolute repoſe is more perfect than the preceding, becauſe the ear, prepoſſeſſed with the mode of *ut* by the multiplied impreſſion of the ſound *ut* which it has already heard thrice before, feels a deſire to return to the generator *ut*; and it accordingly does ſo, by the abſolute repoſe *ſol, ut*.

110 Cadence in melody different from what it is in harmony.

75. We may ſtill add, that what is commonly called *cadence* in melody, ought not to be confounded with what we name *cadence* in harmony.

In the firſt caſe, this word only ſignifies an agreeable and rapid alternation between two contiguous ſounds, called likewiſe a *trill* or *ſhake*; in the ſecond, it ſignifies a repoſe or cloſe. It is however true, that this ſhake implies, or at leaſt frequently enough preſages, a repoſe, either preſent or impending, in the fundamental baſs (x).

111 Cadences in the fundamental baſs neceſſary in the diatonic ſcale, and which the moſt perfect.

76. Since there is a repoſe in paſſing from one ſound to another in the fundamental baſs, there is alſo a repoſe in paſſing from one note to another in the diatonic ſcale, which is formed from it, and which this baſs repreſents: and as the abſolute repoſe *ſol ut*, is of all others the moſt perfect in the fundamental baſs, the repoſe from *ſi* to *ut*, which anſwers to it in the ſcale, and which is likewiſe terminated by the generator, is for that reaſon the moſt perfect of all others in the diatonic ſcale aſcending.

112 Definition and uſe of a ſenſible note.

77. It is then a law dictated by nature itſelf, that if you would aſcend diatonically to the generator of a mode, you can only do this by means of the third major from the fifth of that very generator. This third major, which with the generator forms a ſemitone, has for that reaſon been called the *ſenſible note*, as introducing the generator, and preparing us for the moſt perfect repoſe. See *Senſible Note.*

We have already proved, that the fundamental baſs is the principle of melody. We ſhall beſides make it appear in the ſequel, that the effect of a repoſe in melody ariſes ſolely from the fundamental baſs.

Chap. IX. *Of the Minor Mode and its Diatonic Series.*

113 The diatonic ſeries of the minor mode aſcertained by different examples.

78. In the ſecond chapter, we have explained (art. 29. 30. 31. and 32.) by what means, and upon what principle the minor chord *ut, mi♭, ſol, ut*, may be formed, which is the characteriſtical chord of the minor mode. Now what we have there ſaid, taking *ut* for the principal and fundamental ſound, we might likewiſe have ſaid of any other note in the ſcale, aſſumed in the ſame manner as the principal and fundamental ſound: but as in the minor chord *ut, mi♭ ſol, ut*, there occurs a *mi♭* which is not found in the ordinary diatonic ſcale, we ſhall immediately ſubſtitute, for greater eaſe and conveniency, another chord, which is likewiſe minor and exactly ſimilar to the former, of which all the notes are found in the ſcale.

79. The ſcale affords us three chords of this kind, viz. *re, fa, la, re, la, ut, mi, la*, and *mi, ſol, ſi, mi*. Amongſt theſe three we ſhall chooſe *la, ut, mi, la*; becauſe this chord, without including any ſharp or flat, has two ſounds in common with the major chord *ut, mi, ſol, ut*; and beſides, one of theſe two ſounds is the very ſame *ut*: ſo that this chord appears to have the moſt immediate, and at the ſame time the moſt ſimple, relation with the chord *ut, mi, ſol, ut*. Concerning this we need only add, that this preference of the chord *la, ut, mi, la*, to every other minor chord, is by no means in itſelf neceſſary for what we have to ſay in this chapter upon the diatonic ſcale of the minor mode. We might in the ſame manner have choſen any other minor chord; and it is only, as we have ſaid, for greater eaſe and conveniency, that we fix upon this.

114 Tonic or key in harmony, what. See *Principal.* See *Tonic.*

80. Let us now remark, that in every mode, whether major or minor, the *principal* ſound which implies the perfect chord, whether major or minor, may be called the *tonic note* or *key*; thus *ut* is the key in its proper mode, *la* in the mode of *la*, &c. Having laid down this principle,

114 The formation of the ſcale purſued.

81. We have ſhown how the three ſounds *fa, ut, ſol*, which conſtitutes (art. 38.) the mode of *ut*, of which the firſt *fa* and the laſt *ſol* are the two fifths of *ut*, one deſcending the other riſing, produce the ſcale

ſi,

(†) That the reader may have a clear idea of the term before he enters upon the ſubject of this chapter, it may be neceſſary to caution him againſt a miſtake into which he may be too eaſily led, by the ordinary ſignification of the word *repoſe*. In muſic, therefore, it is far from being ſynonimous with the word *reſt*. It is, on the contrary, the termination of a muſical *phraſe* which ends in a cadence more or leſs emphatic, as the ſentiment implied in the phraſe is more or leſs complete. Thus a repoſe in muſic anſwers the ſame purpoſe as punctuation in language. See Repos in Rouſſeau's Muſical Dictionary.

(x) M. Rouſſeau, in his letter on French muſic, has called this alternate undulation of different ſounds a *trill*, from the Italian word *trillo*, which ſignifies the ſame thing; and ſome French muſicians already appear to have adopted this expreſſion.

Theory of Harmony.

si, ut, re, mi, fa, sol, la, of the major mode, by means of the fundamental bass *sol, ut, sol, ut, fa, ut, fa:* let us in the same manner take the three sounds *re, la, mi,* which constitute the mode of *la,* for the same reason that the sounds *fa, ut, sol,* constitute the mode of *ut;* and of them let us form this fundamental bass, perfectly like the preceding, *mi, la, mi, la, re, la, re:* let us afterwards place below each of these sounds one of their harmonics, as we have done (chap. v.) for the first scale of the major mode; with this difference, that we must suppose *re* and *la* as implying their thirds minor in the fundamental bass to characterise the minor mode; and we shall have the diatonic scale of that mode,

See fig. D.

See fig G.

sol※, *la, si, ut, re, mi, fa.*

82. The *sol*※, which corresponds with *mi* in the fundamental base, forms a third major with that *mi,* though the mode be minor; for the same reason that a third from the fifth of the fundamental sound ought to be major (art. 77.) when that third rises to the fundamental sound *la.*

See *Imply* or *Carry.*

83. It is true, that, in causing *mi* to *imply* its third major *sol,* one might also rise to *la* by a diatonic progress. But that manner of rising to *la* would be less perfect than the preceding; for this reason (art. 76.), that the absolute repose or perfect cadence *mi, la,* which is found in the fundamental bass, ought to be represented in the most perfect manner in the two notes of the diatonic scale which answer to it, especially when one of these two notes is *la,* the key itself upon which the repose is made. From whence it follows, that the preceding note *sol* ought rather to be sharp than natural; because *sol*※, being included in *mi* (art. 19.), much more perfectly represents the note *mi* in the bass, than the natural note *sol* could do, which is not included in *mi.*

116 Diversities in the sales of the major and minor mode.

84. We may remark this first difference between the scale

sol※, *la,* , *ut, re, mi, fa,*

and the scale which corresponds with it in the major mode

si, ut, re, mi, fa, sol, la,

that from *mi* to *fa,* which are the two last notes of the former scale, there is only a semitone; whereas from *sol* to *la,* which are the two last sounds of the latter series, there is the interval of a complete tone: but this is not the only discrimination which may be found between the scales of the two modes.

117 Investigation of these differences and their reasons.

85. To investigate these differences, and to discover the reason for which they happen, we shall begin by forming a new diatonic scale of the minor mode, similar to the second scale of the major mode,

See fig. E.

ut, re, mi, fa, sol, sol, la, si, ut.

That last series, as we have seen, was formed by means of the fundamental bass *fa, ut, sol, re,* disposed in this manner,

ut, sol, ut, fa, ut, sol, re, sol, ut.

Let us take in the same manner the fundamental bass *re la mi si,* and arrange it in the following order,

See fig. H.

la, mi, la, re, la, mi, si, mi, la,

and it will produce the scale immediately subjoined,

la, si, ut, re, mi, mi, fa※, *sol*※, *la,*

in which *ut* forms a third minor with *la,* which in the fundamental bass corresponds with it, which denominates the minor mode: and on the contrary *sol*※ forms a third major with *mi* in the fundamental bass, because *sol*※ rises towards *la,* (art. 82. and 83.)

86. We see besides a *fa*※, which does not occur in the former,

sol※, *la, si, ut, re, mi, fa,*

where *fa* is natural. It is because, in the first scale, *fa* is a third minor from *re* in the bass; and in the second, *fa*※ is the fifth from *si* in the bass.

87. Thus the two scales of the minor mode are still in this respect more different one from the other than the two scales of the major mode; for we do not remark this difference of a semitone between the two scales of the major mode. We have only observed (art. 63.) some difference in the value of *la* as it stands in each of these scales, but this amounts to much less than a semitone.

118 Difference between the two scales of the minor mode greater than between those of the major.

88. From thence it may be seen why *fa* and *sol* are sharp when ascending in the minor mode; nay, besides, the *fa* is only natural in the first scale *sol*※, *la, si, ut, re, mi, fa,* because this *fa* cannot rise to *sol*※, (art. 48.)

119 *Fa* and *sol* sharp in the minor mode, and why.

89. It is not the same case in descending. For *mi,* the fifth of the generator, ought not to imply the third major *sol*※, but in the case when that *mi* descends to the generator *la* to form a perfect repose, (art. 77. and 83.); and in this case the third major *sol*※ rises to the generator *la*: but the fundamental bass *la mi* may, in descending, give the scale *la sol* natural, provided *sol* does not rise towards *la.*

120 The case different in descending, and why.

90. It is much more difficult to explain how the *fa,* which ought to follow this *sol* in descending, is natural and not sharp; for the fundamental bass

la, mi, si, mi, la, re, la, mi, la,

produces in descending,

la, sol, fa※, *mi, mi, re, ut, si, la.*

And it is plain that the *fa* cannot be otherwise than sharp, since *fa*※ is the fifth of the note *si* of the fundamental bass. In the mean time, experience evinces that the *fa* is natural in descending in the diatonic scale of the major mode of *la,* especially when the preceding *sol* is natural; and it must be acknowledged, that here the fundamental bass appears in some measure defective.

121 Explication of the descending scale in the minor mode from a fundamental bass difficult.

M. Rameau has invented the following means for obtaining a solution of this difficulty. According to him, in the diatonic scale of the minor mode in descending, *la, sol, fa, mi, re, ut, si, la, sol,* may be regarded simply as a note of passage, merely added to give sweetness to the modulation, and as a diatonic gradation by which we may descend to *fa* natural. It is easily perceived, according to M. Rameau, by this fundamental bass,

122 Rameau's solution, though the only one, yet unsatisfactory.

la, re, la, re, la, mi, la,

which produces

la, fa, mi, re, ut, si, la;

which may be regarded, as he says, as the real scale of the minor mode in descending; to which is added *sol* natural between *la* and *fa,* to preserve the diatonic order.

This answer appears the only one which can be given to the difficulty above proposed: but I know not whether it will fully satisfy the reader; whether he will not see with regret, that the fundamental bass does not produce, to speak properly, the diatonic scale of the minor

Theory of Harmony.

minor mode in deſcent, when at the ſame time this ſame baſs ſo happily produces the diatonic ſcale of that identical mode in aſcending, and the diatonic ſcale of the major mode whether in riſing or deſcending (Y).

Chap. X. *Of relative Modes.*

123 Modes relative, what. See *Mode.*

91. Two modes which are of ſuch a nature that we can paſs from the one to the other, are called *relative modes*. Thus we have already ſeen, that the major mode of *ut* is relative to the major mode of *fa* and to that of *ſol*. It may likewiſe appear from what goes before, how many intimate connections there are between the *ſpecies* (†) or major mode of *ut*, and the *ſpecies* or minor mode of *la*. For, 1. The perfect chords, one major *ut mi ſol ut*, the other minor *la ut mi la*, which characteriſe each of thoſe two kinds of modulation * or harmony, have two ſounds in common, *ut* or *mi*. 2. The diatonic ſcale of the minor mode of *la* in deſcent, abſolutely contains the ſame ſounds with the gammut or diatonic ſcale of the major mode of *ut*.

* See *Modulation.*

It is for this reaſon that the tranſition is ſo natural and eaſy from the major mode of *ut* to the minor mode of *la*, or from the minor mode of *la* to the major mode of *ut*, as experience proves.

92. In the minor mode of *mi*, the minor perfect chord *mi ſol ſi mi*, which characteriſes it, has likewiſe two ſounds, *mi*, *ſol*, in common with the perfect chord major *ut mi ſol ut*, which characteriſes the major mode of *ut*. But the minor mode of *mi* is not ſo cloſely related nor allied to the major mode of *ut* as to the minor mode of *la*; becauſe the diatonic ſcale of the minor mode of *mi* in deſcent has not, like the ſeries of the minor mode of *la*, all theſe ſounds in common with the ſcale of *ut*. In reality, this ſcale is *mi re ut ſi la ſol fa*♯ *mi*, where there occurs a *fa* ſharp which is not in the ſcale of *ut*. We may add, that though the minor mode of *mi* is leſs relative to the major mode of *ut* than that of *la*; yet the artiſt does not heſitate ſometimes to paſs immediately from the one to the other.

Of this may be ſeen one inſtance (among many others) in the prologue *des Amours des Dieux*, at this paſſage, *Ovide eſt l'objet de la fete*, which is in the minor mode of *mi*, though what immediately precedes it is in the major mode of *ut*.

We may ſee beſides, that when we paſs from one mode to another by the interval of a third, whether in deſcending or riſing, as from *ut* to *la*, or from *la* to *ut*, from *ut* to *mi*, or from *mi* to *ut*, the major mode becomes minor, or the minor mode becomes major.

93. There is ſtill another minor mode, into which an immediate tranſition may be made in iſſuing from the major mode of *ut*. It is the minor mode of *ut* itſelf in which the perfect minor chord *ut mi*♭ *ſol ut* has two ſounds, *ut* and *ſol*, in common with the perfect major chord *ut mi ſol ut*. Nor is there any thing more common than a tranſition from the major mode of *ut* to the minor mode, or from the minor to the major (Z).

Chap. XI. *Of Diſſonance.*

124 Caſes in which the mode is uncertain.

94. We have already obſerved, that the mode of *ut* (*fa*, *ut*, *ſol*,) has two ſounds in common with the mode of *ſol*, (*ut*, *ſol*, *re*); and two ſounds in common with the mode of *fa* (*ſi*♭, *fa*, *ut*); of conſequence this procedure of the baſs *ut ſol*, may belong to the mode of *ut*, or to the mode of *ſol*, as the procedure of the baſs *fa ut*, or *ut fa*, may belong to the mode of *ut* or the mode of *fa*. When any one therefore paſſes from *ut* to *fa* or to *ſol* in a fundamental baſs, he is ſtill ignorant even to that criſis what mode he is in. It would be however advantageous to know it, and to be able by ſome means to diſtinguiſh the generator from its fifths.

125 How we may inveſtigate the generator and its fifths, and by that means determine the mode.

95. This advantage may be obtained by uniting at the ſame time the ſounds *ſol* and *fa* in the ſame harmony, that is to ſay, by joining to the harmony *ſol ſi re* of the fifth *ſol*, the other fifth *fa* in this manner, *ſol*

(Y) For what remains when *ſol* is ſaid to be natural in deſcending the diatonic ſcale of the minor mode of *la*, this only ſignifies, that this *ſol* is not neceſſarily ſharp in deſcending as it is in riſing; for this *ſol*, beſides, may be ſharp in deſcending to the minor mode of *la*, as may be proved by numberleſs examples, of which all muſical compoſers are full. It is true, that when the ſound *ſol* is found ſharp in deſcending to the minor mode of *la*, ſtill we are not ſure that the mode is minor till the *fa* or *ut* natural is found; both of which impreſs a peculiar character on the minor mode, viz. *ut* natural, in riſing and in deſcending, and the *fa* natural in deſcending.

(†) *Species* was the only word which occurred to the tranſlator in Engliſh by which he could render the French word *genre*. It is, according to Rouſſeau, intended to expreſs the different diviſions and diſpoſitions of the intervals which formed the two tetrachords in the ancient diatonic ſcale; and as the gammut of the moderns conſiſts likewiſe of two tetrachords, though diverſified from the former, as our author has ſhown at large, the *genre*, or *ſpecies* as the tranſlator has been obliged to expreſs it, muſt conſiſt in the various diſpoſitions and diviſions of the different intervals between the notes or ſemitones which compoſe the modern ſcale.

(Z) There are likewiſe other minor modes, into which we may paſs in our egreſs from the mode major of *ut*; as that of *fa* minor, in which the perfect minor chord *fa*, *la*♭, *ut*, includes the ſound *ut*, and whoſe ſcale in aſcent *fa*, *ſol*, *la*♭, *ſi*♭, *ut*, *re*, *mi*, *fa*, only includes the two ſounds *la*♭, *ſi*♭, which do not occur in the ſcale of *ut*. We find an example of this tranſition from the mode major of *ut* to that of *fa* minor, in the opera of *Pygmalion* by M. Rameau, where the *ſarabando* is in the minor mode of *fa*, and the *rigadoon* in the mode major of *ut*. This kind of tranſition, however, is not frequent.

The minor mode of *re* has only in its ſcale aſcending *re*, *mi*, *fa*, *ſol*, *la*, *ſi*, *ut*♯, *re*, one *ut* ſharp which is not found in the ſcale of *ut*. For this reaſon a tranſition may likewiſe be made, without grating the ear, from the mode of *ut* major to the mode of *re* minor; but this paſſage is leſs immediate than the former, becauſe the chords *ut*, *mi*, *ſol*, *ut*, *re*, *fa*, *la*, *re*, not having a ſingle ſound in common, one cannot (art. 37.) paſs immediately from the one to the other.

ſol, ſi, re, fa; this *fa* which is added, forms a diſſonance with *ſol* (art. 18.) It is for that reaſon that the chord *ſol ſi re fa*, is called a *diſſonant* chord, or a chord of the ſeventh. It ſerves to diſtinguiſh the fifth *ſol* from the generator *ut*, which always implies, without mixture or alteration, the perfect chord *ut, mi, ſol, ut*, reſulting from nature itſelf (art. 32.) By this we may ſee, that when we paſs from *ut* to *ſol*, one paſſes at the ſame time from *ut* to *fa*, becauſe *fa* is found to be comprehended in the chord of *ſol;* and the mode of *ut* by theſe means plainly appears to be determined, becauſe there is none but that mode to which the ſounds *fa* and *ſol* at once belong.

126 Manner of treating diſſonances continued.

96. Let us now ſee what may be added to the harmony *fa, la, ut*, of the fifth *fa* below the generator, to diſtinguiſh this harmony from that of the generator. It ſeems probable at firſt, that we ſhould add to it the other fifth *ſol*, ſo that the generator *ut*, in paſſing to *fa*, may at the ſame time paſs to *ſol*, and that by this the mode ſhould be determined: but this introduction of *ſol*, in the chord *fa, la, ut*, would produce two ſeconds in ſucceſſion *fa, ſol, ſol, la*, that is two ſay, two diſſonances whoſe union would prove extremely harſh to the ear; an inconvenience which ought carefully to be avoided. For if, to diſtinguiſh the mode, we ſhould alter the harmony of the fifth *fa* in the fundamental baſs, it muſt only be altered in the leaſt degree poſſible.

127 Chord of the great ſixth.

97. For this reaſon, inſtead of *ſol*, we ſhall take its fifth *re*, which is the ſound that approaches it the neareſt; and we ſhall have, inſtead of the fifth *fa*, the chord *fa, la, ut, re*, which is called a *chord of the great ſixth*.

One may here remark the analogy there is obſerved between the harmony of the fifth *ſol*, and that of the fifth *fa*.

128 The ſubject of diſſonances continued.

98. The fifth *ſol*, in riſing above the generator, gives a chord entirely conſiſting of thirds aſcending from *ſol*, *ſol, ſi, re, fa;* now the fifth *fa* being below the generator *ut* in deſcending, we ſhall find, as we go lower by thirds from *ut* towards *fa*, the ſame ſounds *ut, la, fa, re*, which form the chord *fa, la, ut, re*, given to the fifth *fa*.

99. It appears beſides, that the alteration of the harmony in the two fifths conſiſts only in the third minor *re, fa*, which was reciprocally added to the harmony of theſe two fifths.

CHAP. XII. *Of the Double Uſe, or Employment of Diſſonance.*

129 Account of the double employment.

100. It is evident by the reſemblance of ſounds to their octaves, that the chord *fa, la, ut, re*, is in effect the ſame as the chord *re, fa, la, ut*, taken inverſely *, that the inverſe of the chord *ut, la, fa, re*, has been found (art. 98.) in deſcending by thirds from the generator *ut* (AA).

* See *Inverted*.

130 Difference between dominant and tonic dominant.

101. The chord *re, fa, la, ut*, is a chord of the ſeventh like the chord *ſol, ſi, re, fa:* with this only difference, that in this the third *ſol, ſi*, is major; whereas in the ſecond, the third *re, fa*, is minor. If the *fa* were ſharp, the chord *re, fa*✳, *la, ut*, would be a genuine chord of the dominant, like the chord *ſol, ſi, re, fa;* and as the dominant *ſol* may deſcend to *ut* in the fundamental baſs, the dominant *re* implying or carrying with the third major *fa*✳ might in the ſame manner deſcend to *ſol*.

102. Now I ſay, that if the *fa*✳ ſhould be changed into *fa* natural, *re*, the fundamental tone of this chord *re, fa, la, ut*, might ſtill deſcend to *ſol;* for the change from *fa*✳ to *fa* natural, will have no other effect, than to preſerve the impreſſion of the mode of *ut*, inſtead of that of the mode of *ſol*, which the *fa*✳ would have here introduced. For what remains, the note *re* will always preſerve its character as the dominant, on account of the mode of *ut*, which forms a ſeventh. Thus in the chord of which we treat, *re, fa, la, ut, re*, may be conſidered as an *imperfect dominant;* I call it *imperfect*, becauſe it carries with it the third minor *fa*, inſtead of the third major *fa*✳. It is for this reaſon that in the ſequel I ſhall call it ſimply the *dominant*, to diſtinguiſh it from the dominant *ſol*, which ſhall be named the *tonic dominant*.

See *Dominant*.

103. Thus the ſounds *fa* and *ſol*, which cannot ſucceed each other (art. 36.) in a diatonic baſs, when they only carry with them the perfect chords *fa, la, ut, ſol, ſi, re*, may ſucceed one another if you join *re* to the harmony of the firſt, and *fa* to the harmony of the ſecond; and if you invert the firſt chord, that is to ſay, if you give to the two chords this form, *re, fa, la, ut, ſol, ſi, re, fa*.

131 Seeming contradictions reconciled.

104. Beſides, the chord *fa, la, ut, re*, being allowed to ſucceed the perfect chord *ut, mi, ſol, ut*, it follows

(AA) "M. Rameau, in ſeveral paſſages of his works, (for inſtance, in *p.* 110, 111, 112, and 113, of the *Generation Harmonique*,) appears to conſider the chord *re, fa, la, ut*, as the primary chord and generator of the chord *fa, la, ut, re*, which is nothing but that chord itſelf reverſed; in other paſſages (particularly in *p.* 116 of the ſame performance), he ſeems to conſider the firſt of theſe chords as nothing elſe but the reverſe of the ſecond. It would ſeem that this great artiſt has neither expreſſed himſelf upon this ſubject with ſo much uniformity nor with ſo much preciſion as is required. For my own part, I think there is ſome foundation for conſidering the chord *fa, la, ut, re*, as primitive; 1. Becauſe in this chord, the fundamental and principal note is the ſub-dominant *fa*, which ought in effect to be the fundamental and principal ſound in the chord of the ſub-dominant. 2. Becauſe that without having recourſe, with M. Rameau, to harmonical and arithmetical progreſſions, of which the conſideration appears to us quite foreign to the queſtion, we have found a probable and even a ſatisfactory reaſon for adding the note *re* to the harmony of the fifth *fa*, (art. 96 and 97.) The origin thus aſſigned for the chord of the ſub-dominant appears to us the moſt natural, though M. Rameau does not appear to have felt its full value; for ſcarcely has it been ſlightly inſinuated by him."——

Thus far our author. We do not enter with him into the controverſy concerning the origin of the chord in queſtion; but only propoſe to add to his definition of the ſub-dominant, Rouſſeau's idea of the ſame note. It is a name, ſays he, given by M. Rameau to the fourth note in any modulation relative to a given key, which of conſequence is in the ſame interval from the key in deſcending as the dominant in riſing; from which circumſtance it takes its name.

follows for the ſame reaſons, that the chord *ut, mi, ſol, ut*, may be ſucceeded by *re, fa, la, ut;* which is not contradictory to what we have above ſaid (art. 37.), that the ſounds *ut* and *re* cannot ſucceed one another in the fundamental baſs: for in the paſſage quoted, we had ſuppoſed that both *ut* and *re* carried with them a perfect chord major; whereas, in the preſent caſe, *re* carries the third minor *fa* and likewiſe the ſound *ut*, by which the chord *re fa la ut* is connected with that which precedes it *ut mi ſol ut*, and in which the ſound *ut* is found. Beſides, this chord, *re fa la ut*, is properly nothing elſe but the chord *fa la ut re* inverted, and, if we may ſpeak ſo, diſguiſed.

132 Double employment, what, and why ſo called. * See *Double employment.*

105. This manner of preſenting the chord of the ſub-dominant under two different forms, and of employing it under theſe two different forms, has been called by M. Rameau its *double office* or *employment* *. This is the ſource of one of the fineſt varieties in harmony; and we ſhall ſee in the following chapter the advantages which reſult from it.

We may add, that as this double employment is a kind of licence, it ought not to be practiſed without ſome precaution. We have lately ſeen that the chord *re fa la ut*, conſidered as the inverſe of *fa la ut re*, may ſucceed to *ut mi ſol ut;* but this liberty is not reciprocal: and though the chord *fa la ut re*, may be followed by the chord *ut mi ſol ut*, we have no right to conclude from thence that the chord *re fa la ut*, conſidered as the inverſe of *fa la ut re*, may be followed by the chord *ut mi ſol ut*. For this the reaſon ſhall be given Chap. XVI.

Chap. XIII. *Concerning the Uſe of this Double Employment, and its Rules.*

133 By the double uſe of the abovementioned chord, the impreſſion of the mode may be preſerved.

106. We have ſhown (Chap. vi.) how the diatonic ſcale, or ordinary gammut, may be formed from the fundamental baſs *fa, ut, ſol, re*, by twice repeating the word *ſol* in that ſeries; ſo that this gammut is primitively and originally compoſed of two ſimilar tetrachords, one in the mode of *ut*, the other in that of *ſol*. Now it is poſſible, by means of this double employment, to preſerve the impreſſion of the mode of *ut* through the whole extent of the ſcale, without twice repeating the note *ſol*, or even without ſuppoſing this repetition. For this effect we have nothing to do but form the following fundamental baſe,

ut, ſol, ut, fa, ut, re, ſol, ut:

in which *ut* is underſtood to carry with it the perfect chord *ut mi ſol ut; ſol*, the chord *ſol ſi re fa; fa*, the chord *fa la ut re;* and *re*, the chord *re fa la ut*. It is plain from what has been ſaid in the preceding chapter, that in this caſe *ut* may aſcend to *re* in the fundamental baſs, and *re* deſcend to *ſol;* and that the impreſſion of the mode of *ut* is preſerved by the *fa* natural which forms the third minor *re fa*, inſtead of the third major which *re* ought naturally to imply.

107. This fundamental baſs will give, as it is evident, the ordinary diatonic ſcale,

ut, re, mi, fa, ſol, la, ſi, UT,

which of conſequence will be in the mode of *ut* alone; and if one ſhould chooſe to have the ſecond tetrachord in the mode of *ſol*, it will be neceſſary to ſubſtitute *fa*※ inſtead of *fa* natural in the harmony of *re* (BB).

108. Thus the generator *ut* may be followed according to pleaſure in aſcending diatonically either by a tonic dominant (*re fa*※ *la ut*), or by a ſimple dominant (*re fa la ut*).

109. In the minor mode of *la*, the tonic dominant *mi* ought always to imply its third major *mi ſol*※, when this dominant *mi* deſcends to the generator *la* (art. 83.); and the chord of this dominant ſhall be *mi ſol*※ *ſi re*, entirely ſimilar to *ſol ſi re fa*. With reſpect to the ſub-dominant *re*, it will immediately imply the third minor *fa*, to denominate the minor mode; and we may add *ſi* above its chord *re fa la*, in this manner *re fa la ſi*, a chord ſimilar to that of *fa la ut re;* and as we have deduced from the chord *fa la ut re*, that of *re fa la ut*, we may in the ſame manner deduce from the chord *re fa la ſi*, a new chord of the ſeventh *ſi re fa la*, which will exhibit the *double employment of diſſonances* in the minor mode.

110. One may employ this chord *ſi re fa la*, to preſerve the impreſſion of the mode of *la* in the diatonic ſcale of the minor mode, and to prevent the neceſſity of twice repeating the ſound *mi:* but in this caſe, the *fa* muſt be rendered ſharp, and change this chord to *ſi re fa*※ *la*, the fifth of *ſi* is *fa*※, as we have ſeen above; this chord is then the inverſe of *re fa*※ *la ſi*, where the ſub-dominant implies the third major; which ought not to ſurpriſe us. For in the minor mode of *la*, the ſecond tetrachord *mi fa*※ *ſol*※ *la* is exactly the ſame as it would be in the major mode of *la;* now, in the major mode of *la*, the ſub-dominant *re* ought to imply the third major *fa*※.

134 Diverſities in the minor mode more numerous than in the major.

111. From thence we may ſee that the minor mode is ſuſceptible of a much greater number of varieties than the major: likewiſe the major mode is the product of nature alone; whereas the minor is, in ſome meaſure,

(BB) We need only add, that it is eaſy to ſee, that this fundamental baſe *ut ſol, ut fa, ut re, ſol ut*, which formed the aſcending ſcale *ut, re, mi, fa, ſol, la, ſi, UT*, cannot by inverting it, and taking it inverſely in this manner *ſi, ut, ſol, re, ut, fa, ut, ſol, UT*, form the diatonic ſcale *UT, ſi, la, ſol, fa, mi, re, ut*, in deſcent. In reality, from the chord *ſol, ſi, re, fa*, we cannot paſs to the chord *re, fa, la, ut*, nor from thence to *ut, mi, ſol, ut*. It is for this reaſon that in order to have the fundamental baſs of the ſcale *UT, ſi, la, ſol, fa, mi, re, ut*, in deſcent, we muſt either determine to invert the fundamental baſs mentioned in art. 55. in this manner, *ut, ſol, re, ſol, ut, fa, ut, ſol, ut*, in which the ſecond *ſol* and the ſecond *ut* anſwer to the *ſol* alone in the ſcale; or otherwiſe we muſt form the fundamental baſs *ut, ſol, re, ſol, ut, ſol, ut*, in which all the notes imply perfect chords major, except the ſecond *ſol*, which implies the chord of the ſeventh *ſol, ſi, re, fa*, and which anſwers to the two notes of the ſcale *ſol, fa*, both comprehended in the chord *ſol, ſi, re, fa*.

Which ever of theſe two baſſes we ſhall chooſe, it is obvious that neither the one nor the other ſhall be wholly in the mode of *ut*, but in the mode of *ut* and in that of *ſol*. From whence it follows, that the double employment which gives to the ſcale a fundamental baſs all in the ſame mode when aſcending, cannot do the ſame in deſcending; and that the fundamental baſs of the ſcale in deſcending will be neceſſarily in two different modes.

Theory of Harmony

meaſure, the product of art. But in return, the major mode has received from nature, to which it owes its immediate formation, a force and energy which the minor cannot boaſt.

CHAP. XIV. *Of the Different Kinds of Chords of the Seventh.*

135 Inveſtigation whether art, in conſequence of ſome ſucceſsful advances, may not be carried farther.

112. THE diſſonance added to the chord of the dominant and of the ſub-dominant, though in ſome meaſure inſinuated by nature (Chap. xi.), is nevertheleſs a work of art: but as it produces great beauties in harmony by the variety which it introduces into it, let us diſcover whether, in conſequence of this firſt advance, art may not ſtill be carried farther.

113. We have already three different kinds of chords of the ſeventh, *viz.*

136 Different chords of the ſeventh.

1. The chord *ſol ſi re fa*, compoſed of a third major followed by two thirds minor.

2. The chord *re fa la ut*, or *ſi re fa*♯ *la*, compoſed of a third major between two minors.

3. The chord *ſi re fa la*, compoſed of two thirds minor followed by a major.

114. There are ſtill two other kinds of chords of the ſeventh which are employed in harmony; one is compoſed of a third minor between two thirds major, *ut mi ſol ſi*, or *fa la ut mi;* the other is wholly compoſed of thirds minor *ſol*♯ *ſi re fa.* Theſe two chords, which at firſt appear as if they ought not to enter into harmony if we rigorouſly keep to the preceding rules, are nevertheleſs frequently practiſed with ſucceſs in the fundamental baſs. The reaſon is this:

137 The chords laſt deſcribed admiſſible, and why.

115. According to what has been ſaid above, if we would add a ſeventh to the chord *ut mi ſol*, to make a dominant of *ut*, one can add nothing but *ſi*♭; and in this caſe *ut mi ſol ſi*♭ would be the chord of the tonic dominant in the mode of *fa*, as *ſol ſi re fa* is the chord of the tonic dominant in the mode of *ut:* but if you would preſerve the impreſſion of the mode of *ut* in the harmony, you then change this *ſi*♭ into *ſi* natural, and the chord *ut mi ſol ſi*♭ becomes *ut mi ſol ſi.* It is the ſame caſe with the chord *fa la ut mi*, which is nothing elſe but the chord *fa la ut mi*♭; in which one may ſubſtitute for *mi*♭, *mi* natural, to preſerve the impreſſion of the mode of *ut*, or of that of *fa.*

Beſides, in ſuch chords as *ut mi ſol ſi*, *fa la ut mi*, the ſounds *ſi* and *mi*, though they form a diſſonance with *ut* in the firſt caſe, and with *fa* in the ſecond, are nevertheleſs ſupportable to the ear, becauſe theſe ſounds *ſi* and *mi* (art. 19.) are already contained and underſtood, the firſt in the note *mi* of the chord *ut mi ſol ſi*, as likewiſe in the note *ſol* of the ſame chord; the ſecond in the note *la* of the chord *fa la ut mi*, as likewiſe in the note *ut* of the ſame chord. All together then ſeem to allow the artiſt to introduce the note *ſi* and *mi* into theſe two chords (CC).

138 Chords of the ſeventh continued and explained.

116. With reſpect to the chord of the ſeventh *ſol*♯ *ſi re fa*, wholely compoſed of thirds minor, it may be regarded as formed from the union of the two chords of the dominant and of the ſub-dominant in the minor mode. In effect, in the minor mode of *la*, for inſtance, theſe two chords are *mi ſol*♯ *ſi re*, and *re fa la ſi*, whoſe union produces *mi*, *ſol*♯, *ſi*, *re*, *fa*, *la:* Now if we ſhould ſuffer this chord to remain thus, it would be diſagreeable to the ear, by its multiplicity of diſſonances, *re mi*, *mi la*, *la ſol*♯, *la ſi*, *re ſol*♯, (art. 18.); ſo that, to avoid this inconveniency, the generator *la* is immediately expunged, which (art. 19.) is as it were underſtood in *re*, and the fifth or dominant *mi* whoſe place the ſenſible note *ſol*♯ is ſuppoſed to hold: thus there remains no more than the chord *ſol*♯ *ſi re fa*, wholly compoſed of thirds minor, and in which the dominant *mi* is conſidered as underſtood; in ſuch a manner that the chord *ſol*♯ *ſi re fa*, repreſents the chord of the tonic dominant *mi ſol*♯ *ſi re*, to which we have joined the chord of the ſub-dominant *re fa la ſi*, but in which the dominant *mi* is always reckoned the principal note (DD).

117. Since, then, from the chord *mi ſol*♯ *ſi re*, we may paſs to the perfect *la ut mi la*, and *vice verſa;* we may in like manner paſs from the chord *ſol*♯ *ſi re fa*, to the chord *la ut mi la*, and from this laſt to the chord *ſol*♯ *ſi re fa:* this remark will be very uſeful to us in the ſequel.

CHAP. XV. *Of the Preparation of Diſcords.*

139 Diſſonance, what.

118. In every chord of the ſeventh, the higheſt note, that is to ſay, the ſeventh above the fundamental, is called a *diſſonance* or *diſcord;* thus *fa* is the diſſonance of the chord *ſol ſi re fa*, *ut* in the chord *re fa la ut*, &c.

140 Manner of preparing diſſonances inveſtigated.

119. When the chord *ſol ſi re fa* follows the chord *ut mi ſol ut*, as this may happen, and in reality often happens, it is obvious that we do not find the diſſonance *fa* in the preceding chord *ut mi ſol ut.* Nor ought it indeed to be found in that chord; for this diſſonance is nothing elſe but the ſub-dominant added to the harmony of the dominant to determine the mode: now, the ſub-dominant is not found in the harmony of the generator.

120. For the ſame reaſon, when the chord of the ſub-

(CC) On the contrary, a chord ſuch as *ut mi*♭ *ſol ſi*, in which *mi* would be flat, could not be admitted in harmony, becauſe in this chord the *ſi* is not included and underſtood in *mi*♭. It is the ſame caſe with ſeveral other chords, ſuch as *ſi re fa la*♯, *ſi re*♯ *fa la*, &c. It is true, that in the laſt of theſe chords, *la* is included in *fa*, but it is not contained in *re*♯; and this *re*♯ likewiſe forms with *fa* and with *la* a double diſſonance, which, joined with the diſſonance *ſi fa*, would neceſſarily render this chord not very pleaſing to the *ear:* we ſhall yet, however, ſee in the ſecond part, that this chord is ſometimes uſed.

(DD) We have ſeen above (art 109.) that the chord *ſi re fa la*, in the minor mode of *la*, may be regarded as the inverſe of the chord *re fa la ſi:* it would likewiſe ſeem, that, in certain caſes, this chord *ſi re fa la* may be conſidered as compoſed of the two chords *ſol ſi re fa*, *fa la ut re*, of the dominant and of the ſub-dominant of the major mode of *ut;* which chords may be joined together, after having excluded from them, 1. The dominant *ſol*, repreſented by its third major *ſi*, which is preſumed to retain its place. 2. The note *ut* which is underſtood in *fa;* which will form this chord *ſi re fa la.* The chord *ſi re fa la*, conſidered in this point of view, may be underſtood as belonging to the major mode of *ut* upon certain occaſions.

ſub-dominant *fa la ut re* follows the chord *ut mi ſol ut*, the note *re*, which forms a diſſonance with *ut*, is not found in the preceding chord.

It is not ſo when the chord *re fa la ut* follows the chord *ut mi ſol ut;* for *ut*, which forms a diſſonance in the ſecond chord, ſtands as a conſonance in the preceding.

141 Diſſonance is only tolerable to the ear when found in preceding chords.

121. In general, diſſonance being the production of art (Chap. xi.), eſpecially in ſuch chords as are not of the tonic dominant nor ſub-dominant; the only means to prevent its diſpleaſing the ear by appearing too heterogeneous to the chord, is, that it may be, if we may ſpeak ſo, announced to the ear by being found in the preceding chord, and by that means ſerve to connect the two chords. From whence follows this rule:

142 Preparation of diſſonances how performed.

122. In every chord of the ſeventh, which is not the chord of the tonic dominant, that is to ſay, (art. 102.) which is not compoſed of a third major followed by two thirds minor, the diſſonance which this chord forms ought to ſtand as a conſonance in the chord which precedes it.

See *Preparation.*

This is what we call a *prepared diſſonance.*

123. From thence it follows, that in order to prepare a diſſonance, it is abſolutely neceſſary that the fundamental baſs ſhould aſcend by the interval of a ſecond, as

UT mi ſol ut, RE fa la ut;

or deſcend by a third, as

UT mi ſol ut, LA ut mi ſol;

or deſcend by a fifth, as

UT mi ſol ut, FA la ut mi:

in every other caſe the diſſonance cannot be be prepared. This is what may be eaſily aſcertained. If, for inſtance, the fundamental baſs riſes by a third, as *ut mi ſol ut, mi ſol ſi re*, the diſſonance *re* is not found in the chord *ut mi ſol ut*. The ſame might be ſaid of *ut mi ſol ut, ſol ſi re fa*, and *ut mi ſol ut, ſi re fa la*, in which the fundamental baſs riſes by a fifth or deſcends by a ſecond.

124. It may only be added, that when a tonic, that is to ſay, a note which carries with it a perfect chord, is followed by a dominant in the interval of a fifth or third, this procedure may be regarded as a proceſs from that ſame tonic to another, which has been rendered a dominant by the additiou of the diſſonance.

Moreover, we have ſeen (art. 119, and 120.) that a diſſonance does not ſtand in need of preparation in the chords of the tonic dominant and of the ſub-dominant: from whence it follows, that every tonic carrying with it a perfect chord, may be changed into a tonic dominant (if the perfect chord be major), or into a ſub-dominant (whether the chord be major or minor) by adding the diſſonance all at once.

Chap. XVI. *Of the Rule for* reſolving *Diſſonances.*

143 Diſſonances to be reſolved, muſt be diſguiſed and made to appear in the character of harmonics.

125. We have ſeen (Chap. v. and vi.) how the diatonic ſcale, ſo natural to the voice, is formed by the harmonics of fundamental ſounds; from whence it follows, that the moſt natural ſucceſſion of harmonical ſounds is to be diatonic. To give a diſſonance then, in ſome meaſure, as much the character of an harmonic ſound as may be poſſible, it is neceſſary that this diſſonance, in that part of the modulation where it is found, ſhould deſcend or riſe diatonically upon another note, which may be one of the conſonances of the ſubſequent chord.

144 In the chord of the tonic dominant, the diſſonance ſhould rather riſe than deſcend, and why.

126. Now in the chord of the tonic dominant it ought rather to deſcend than to riſe; for this reaſon. Let us take, for inſtance, the chord *ſol ſi re fa* followed by the chord *ut mi ſol ut;* the part which formed the diſſonance *fa* ought to deſcend to *mi* rather than riſe to *ſol*, though both the ſounds *mi* and *ſol* are found in the ſubſequent chord *ut mi ſol ut;* becauſe it is more natural and more conformed to the connection which ought to be found in every part of the muſic, that *ſol* ſhould be found in the ſame part where *ſol* has already been ſounded, whilſt the other part was ſounding *fa*, as may be here ſeen (parts firſt and fourth)

Firſt part,	- -	*fa mi*,
Second,	- - -	*ſi ut*,
Third,	- - -	*re ut*,
Fourth,	- - -	*ſol ſol*,
Fundamental baſs,	-	*ſol ut.*

145 Conſequences of the former rule.

127. For the ſame reaſon, in the chord of the ſimple dominant *re fa la ut*, followed by *ſol ſi re fa*, the diſſonance *ut* ought rather to deſcend to *ſi* than riſe to *re*.

146 Another conſonance.

128. In ſhort, for the ſame reaſon, we ſhall find, that in the chord of the ſub-dominant *fa la ut re*, the diſſonance *re* ought to riſe to *mi* of the following chord *ut mi ſol ut*, rather than deſcend to *ut;* whence may be deduced the following rules.

147 But is deduced from the former propoſitions.

129. 1°. In every chord of the dominant, whether tonic or ſimple, the note which conſtitutes the ſeventh, that is to ſay the diſſonance, ought diatonically to deſcend upon one of the notes which form a conſonance in the ſubſequent chord.

2°. In every chord of the ſub-dominant, the diſſonance ought to riſe diatonically upon the third of the ſubſequent chord.

148 Diſſonance reſolved, what. See *Reſolution.*

130. A diſſonance which deſcends or riſes diatonically according to theſe two rules, is called a *diſſonance reſolved.*

From theſe rules it is a neceſſary reſult, that the chord of the ſeventh *re fa la ut*, though one ſhould even conſider it as the inverſe of *fa la ut re*, cannot be ſucceeded by the chord *ut mi ſol ut*, ſince there is not in this laſt chord of *ſi* any note upon which the diſſonance *ut* of the chord *re fa la ut* can deſcend.

One may beſides find another reaſon for this rule, in examining the nature of the double employment of diſſonances. In effect, in order to paſs from *re fa la ut*, to *ut mi ſol ut*, it is neceſſary that *re fa la ut*, ſhould in this caſe be underſtood as the inverſe of *fa la ut re*. Now the chord *re fa la ut*, can only be conceived as the inverſe of *fa la ut re*, when this chord *re fa la ut* precedes or immediately follows the *ut mi ſol ut;* in every other caſe the chord *re fa la ut* is a primitive chord, formed from the perfect minor chord *re fa la*, to which the diſſonance *ut* was added, to take from *re* the character of a tonic. Thus the chord *re fa la ut*, could not be followed by the chord *ut mi ſol ut*, but after having been preceded by the ſame chord. Now, in this caſe, the *double employment* would be entirely a futile expedient, without producing any agreeable effect, becauſe, inſtead of this ſucceſſion

ceſſion of chords, *ut mi ſol ut, re fa la ut, ut mi ſol ut*, it would be much more eaſiy and natural to ſubſtitute this other, which furniſhes this natural proceſs, *ut mi ſol ut, fa la ut re, ut mi ſol ut*. The proper uſe of the double employment is, that, by means of inverting the chord of the ſub-dominant, it may be able to paſs from that chord thus inverted, to any other chord except that of the tonic, to which it naturally leads.

CHAP. XVII. *Of the Broken or Interrupted Cadence.*

149 The teſt of perfection in cadences to be found in the fundamental baſs.

131. IN a fundamental baſe which moves by fifths, there is always, as we have formerly obſerved (Chap. viii.), a repoſe more or leſs perfect from one ſound to another; and of conſequence there muſt likewiſe be a repoſe more or leſs perfect from one ſound to another in the diatonic ſcale, which reſults from that baſs. It may be demonſtrated by a very ſimple experiment, that the cauſe of a repoſe in melody is ſolely in the fundamental baſs expreſſed or underſtood. Let any perſon ſing theſe three notes *ut re ut*, performing on the *re* a ſhake, which is commonly called a *cadence*; the modulation will appear to him to be finiſhed after the ſecond *ut*, in ſuch a manner that the ear will neither expect nor wiſh any thing to follow. The caſe will be the ſame if we accompany this modulation with its natural fundamental baſs *ut ſol ut*: but if, inſtead of that baſs, we ſhould give it the following, *ut ſol la*; in this caſe the modulation *ut re ut* would not appear to be finiſhed, and the ear would ſtill expect and deſire ſomething more. This experiment may eaſily be made.

150 Broken cadences, what, and why. See *Cadence*.

132. This paſſage *ſol la*, when the dominant *ſol* diatonically aſcends upon the note *la*, inſtead of deſcending by a fifth upon the generator *ut*, as it ought naturally to do, is called a *broken cadence*; becauſe the perfect cadence *ſol ut*, which the ear expected after the dominant *ſol*, is, if we may ſpeak ſo, broken and ſuſpended by the tranſition from *ſol* to *la*.

133. From thence it follows, that if the modulation *ut re ut* appeared finiſhed when we ſuppoſed no baſs to it at all, it is becauſe its natural fundamental baſs *ut ſol ut* is ſuppoſed to be implied; becauſe the ear deſires ſomething to follow this modulation, as ſoon as it is reduced to the neceſſity of hearing another baſs.

151 Origin of interrupted cadence in the double employment of diſſonances,

134. The interrupted cadence may, as it ſeems to me, be conſidered as having its origin in the *double employment of diſſonances*; ſince this cadence, like the double employment, only conſiſts in a diatonic procedure of the baſs aſcending (chap. xii.) In effect, nothing hinders us to deſcend from the chord *ſol ſi re fa* to the chord *ut mi ſol la*, by converting the tonic *ut* into a ſub-dominant, that is to ſay, by paſſing all at once from the mode of *ut* to the mode of *ſol*: now to deſcend from *ſol ſi re fa* to *ut mi ſol la* is the ſame thing as to riſe from the chord *ſol ſi re fa* to the chord *la ut mi ſol*, in changing the chord of the ſubdominant *ut mi ſol la* for the imperfect chord of the dominant, according to the laws of the double employment.

152 Manner of performing this cadence.

135. In this kind of cadence, the diſſonance of the firſt chord is reſolved by deſcending diatonically upon the fifth of the ſubſequent chord. For inſtance, in the broken cadence *ſol ſi re fa, la ut mi ſol*, the diſſonance *fa* is reſolved by deſcending diatonically upon the fifth *mi*.

153 Interrupted cadence, what. See *Cadence*.

136. There is ſtill another kind of cadence called an *interrupted cadence*, where the dominant deſcends by a third to another dominant, inſtead of deſcending by a fifth upon the tonic, as in this proceſs of the baſs, *ſol ſi re fa, mi ſol ſi re*; in the caſe of an interrupted cadence, the diſſonance of the former chord is reſolved by deſcending diatonically upon the octave of the fundamental note of the ſubſequent chord, as may be here ſeen, where *fa* is reſolved upon the octave of *mi*.

154 Origin of this kind of cadence, likewiſe in the double employment.

137. This kind of interrupted cadence, as it ſeems to me, has likewiſe its origin in the double employment of diſſonances. For let us ſuppoſe theſe two chords in ſucceſſion, *ſol ſi re fa, ſol ſi re mi*, where the note *ſol* is ſucceſſively a tonic dominant and ſub-dominant; that is to ſay, in which we paſs from the mode of *ut* to the mode of *re*; if we ſhould change the ſecond of theſe chords into the chord of the dominant, according to the laws of the double employment, we ſhall have the interrupted cadence *ſol ſi re fa, mi ſol ſi re*.

CHAP. XVIII. *Of the Chromatic Species.*

155 Fundamental baſs may be formed by thirds major.

138. THE ſeries or fundamental baſs by fifths produces the diatonic ſpecies in common uſe (chap. vi.): now the third major being one of the harmonics of a fundamental ſound as well as the fifth, it follows, that we may form fundamental baſſes by thirds major, as we have already formed fundamental baſſes by fifths.

156 A chromatic interval, or minor ſemitone, how found. See *fig*. K.

139. If then we ſhould form this baſs *ut, mi, ſol*♯, the two firſt ſounds carrying each along with it their thirds major and fifths, it is evident that *ut* will give *ſol*, and that *mi* will give *ſol*♯: now the ſemitone which is between this *ſol* and this *ſol*♯ is an interval much leſs than the ſemitone which is found in the diatonic ſcale between *mi* and *fa*, or between *ſi* and *ut*. This may be aſcertained by calculation (EE); it is for this reaſon that the ſemitone from *mi* to *fa* is called *major*, and the other *minor* (FF).

140. If

(EE) In reality, *ut* being ſuppoſed 1 as we have always ſuppoſed it, *mi* is $\frac{4}{5}$, and *ſol*♯ $\frac{25}{16}$: now *ſol* being $\frac{3}{2}$, *ſol*♯ then ſhall be to *ſol* as $\frac{25}{16}$ to $\frac{3}{2}$; that is to ſay, as 25 times 2 to 3 times 16: the proportion then of *ſol*♯ to *ſol* is as 25 to 24, an interval much leſs than that of 16 to 15, which conſtitutes the ſemitone from *ut* to *ſi*, or from *fa* to *mi* (note L).

(FF) It may be obſerved, that a minor joined to a major ſemitone, will form a minor tone; that is to ſay, if one riſes, for inſtance, from *mi* to *fa*, by the interval of a ſemitone major, and afterwards from *fa* to *fa*♯ by the interval of a minor ſemitone, the interval from *mi* to *fa*♯ will be a minor tone. For let us ſuppoſe *mi* to be 1, *fa* will $\frac{16}{15}$, and *fa*♯ will be $\frac{25}{24}$ of $\frac{16}{15}$; that is to ſay, 25 times 16 divided 24 times 15, or $\frac{10}{9}$; *mi* then is to *fa*♯ as 1 is to $\frac{10}{9}$, the interval which conſtitutes the minor tone (note N.)

With reſpect to the tone major, it cannot be exactly formed by two ſemitones; for, 1. Two major ſemitones in

Theory of Harmony.

140. If the fundamental bafs fhould proceed by thirds minor in this manner, *ut*, *mi*♭, a fucceffion which is allowed when we have inveftigated the origin of the minor mode (chap. ix.), we fhall find this modulation *fol*, *fol*♭, which would likewife give a minor femitone (GG).

157 An intonation minor femitone difficult to be hit, and why.

141. The minor femitone is hit by young practitioners in intonation with more difficulty than the femitone major. For which this reafon may be affigned: The femitone major which is found in the diatonick fcale, as from *mi* to *fa*; refults from a fundamental bafs by fifths *ut fa*, that is to fay, by a fucceffion which is moft natural, and for this reafon the eafieft to the ear. On the contrary, the minor femitone arifes from a fucceffion by thirds, which is ftill lefs natural than the former. Hence, that fcholars may truly hit the minor femitone, the following artifice is employed. Let us fuppofe, for inftance, that they intend to rife from *fol* to *fol*♯; they rife at firft from *fol* to *la*, then defcend from *la* to *fol*♯ by the interval of a femitone major; for this *fol* fharp, which is a femitone major below *la*, proves a femitone minor above *fol*. [See the notes (EE) and (FF).]

158 Minor femitone to be found in every procedure of the fundamental bafs by thirds.

142. Every procedure of the fundamental bafs by thirds, whether major or minor, rifing or defcending, gives the minor femitone. This we have already feen from the fucceffion of thirds in afcending. The feries of thirds minor in defcending, *ut*, *la*, gives *ut*, *ut*♯ (HH); and the feries of thirds major in defcending, *ut*, *la*♭, gives *ut*, *ut*♭ (II).

Theory of Harmony.

159 The minor femitone when prevalent, conftitutes chromatic mufic.

143. The minor femitone conftitutes the fpecies called *chromatic*; and with the fpecies which moves by diatonic intervals, refulting from the fucceffion of fifths (chap. v. and vi.), it comprehends the whole of melody.

Chap. XIX. *Of the Enharmonic Species.*

160 Diefis or enharmonic interval, what, and how formed.

144. The two extremes, or higheft and loweft notes, *ut fol*♯, of the fundamental bafs by thirds major, *ut mi fol*♯, give this modulation *ut fi*♯; and thefe two founds *ut*, *fi*♯, differ between themfelves by a fmall interval which is called the *diëfis*, or *enharmonic fourth* of a tone* (LL), which is the difference between a femitone major and a femitone minor (MM). This quarter tone is inappretiable by the ear, and impracticable upon feveral of our inftruments. Yet have means been found to put it in practice in the following manner, or rather to perform what will have the fame effect upon the ear.

* See *Fourth of a Tone*.

161 Manner of feemingly introducing this interval upon inftruments of fixed fcales.

145. We have explained (art. 116.) in what manner the chord *fol*♯ *fi re fa* may be introduced into the minor mode, entirely confifting of thirds minor perfectly true, or at leaft fuppofed fuch. This chord fupplying the place of the chord of the dominant (art. 116.)

in immediate fucceffion would produce more than a tone major. In effect, $\frac{16}{15}$ multiplied by $\frac{16}{15}$ gives $\frac{256}{225}$, which is greater than $\frac{3}{8}$, the interval which conftitutes (note N), the major tone. 2. A femitone minor and a femitone major would give lefs than a major tone, fince they amount only to a true minor. 3. And, *à fortiori*, two minor femitones would give ftill lefs.

(GG) In effect, *mi*♭ being $\frac{6}{5}$, *fol*♭ will be $\frac{6}{5}$ of $\frac{6}{5}$; that is to fay, (note C) $\frac{36}{25}$: now the proportion of $\frac{3}{2}$ to $\frac{36}{25}$ (note C) is that of 3 times 25 to 2 times 36; that is to fay, as 25 to 24.

(HH) *La* being $\frac{5}{6}$, *ut*♯ is $\frac{5}{4}$ of $\frac{5}{6}$; that is to fay $\frac{25}{24}$, and *ut* is 1: the proportion then between *ut* and *ut*♯ is that of 1 to $\frac{25}{24}$, or of 24 to 25.

(II) *La*♭ being the third major below *ut*, will be $\frac{4}{5}$ (note C): *ut*♭, then, is $\frac{7}{5}$ of $\frac{4}{5}$; that is to fay $\frac{24}{25}$. The proportion, then, between *ut* and *ut*♭ is as 25 to 24.

(LL) *Sol*♯ being $\frac{25}{16}$, and *fi*♯ being $\frac{5}{4}$ of $\frac{25}{16}$, we fhall have *fi*♯ equal (note C) to $\frac{125}{64}$, and its octave below fhall be $\frac{125}{128}$; an interval lefs than unity by about $\frac{3}{128}$ or $\frac{1}{43}$. It is plain then from this fraction, that the *fi*♯ in queftion muft be confiderably lower than *ut*.

This interval has been called *the fourth of a tone*, and this denomination is founded on reafon. In effect, we may diftinguifh in mufic four kinds of quarter tones.

1. The fourth of a tone major: now, a tone major being $\frac{9}{8}$, and its difference from unity being $\frac{1}{8}$, the difference of this quarter tone from unity will be almoft the fourth of $\frac{1}{8}$; that is to fay, $\frac{1}{32}$.

2. The fourth of a tone minor; and as a tone minor, which is $\frac{10}{9}$, differs from unity by $\frac{1}{9}$, the fourth of a minor tone will differ from unity about $\frac{1}{36}$.

3. One half of a tone major; and as this femitone differs from unity by $\frac{1}{15}$, one half of it will differ from unity about $\frac{1}{30}$.

4. Finally, one half of a femitone minor, which differs from unity by $\frac{1}{24}$: its half then will be $\frac{1}{48}$.

The interval, then, which forms the enharmonic fourth of a tone, as it does not differ from unity but by $\frac{1}{43}$, may juftly be called the *fourth of a tone*, fince it is lefs different from unity than the largeft interval of a quarter tone, and more than the leaft.

We fhall add, that fince the enharmonic fourth of a tone is the difference between a femitone major and a femitone minor; and fince the tone minor is formed (note FF) of two femitones, one major and the other minor; it follows, that two femitones major in fucceffion form an interval larger than that of a tone by the enharmonic fourth of a tone; and that two minor femitones in fucceffion form an interval lefs than a tone by the fame fourth of a tone.

(MM) That is to fay, that if you rife from *mi* to *fa*, for inftance, by the interval of a femitone major, and afterwards, returning to *mi*, you fhould rife by the interval of a femitone minor to another found which is not in the fcale, and which I fhall mark thus, *fa*+, the two founds *fa*+ and *fa* will form the enharmonic fourth of a tone: for *mi* being 1, *fa* will be $\frac{16}{15}$; and *fa*+ $\frac{25}{24}$: the proportion then between *fa*+ and *fa* is that of $\frac{25}{24}$ to $\frac{16}{15}$ (note C); that is to fay, as 25 times 15 to 16 times 24; or otherwife, as 25 times 5 to 16 times 8, or as 125 to 128. Now this proportion is the fame which is found, in the beginning of the preceding note, to exprefs the enharmonic fourth of a tone.

Theory of Harmony.

116.) from thence we may pafs to that of the tonic or generator *la* (art. 117.). But we muft remark,

1. That this chord *fol※ fi re fa*, entirely confifting of thirds minor, may be inverted or modified according to the three following arrangements, *fi re fa fol※*, *re fa fol※ fi*, *fa fol※ fi re*; and that in all thefe three different ftates, it will ftill remain compofed of thirds minor; or at leaft there will only be wanting the enharmonic fourth of a tone to render the third minor between *fa* and *fol※* entirely juft; for a true third minor, as that from *mi* to *fol* in the diatonic fcale, is compofed of a femitone and a tone both major. Now from *fa* to *fol* there is a tone major, and from *fol* to *fol※* there is only a minor femitone. There is then awanting (art. 144.) the enharmonic fourth of a tone, to render the third *fa fol※* exactly true.

2. But as this divifion of a tone cannot be found in the gradations of any fcale practicable upon moft of our inftruments, nor be appretiated by the ear, the ear takes the different chords,

fi re fa fol※
re fa fol※ fi,
fa fol※ fi re,

which are abfolutely the fame, for chords compofed every one of thirds minor exactly juft.

Now the chord *fol※ fi re fa*, belonging to the minor mode of *la*, where *fol※* is the fenfible note; the chord *fi re fa fol※*, or *fi re fa la♭*, will, for the fame reafon, belong to the minor mode of *ut*, where *fi* is the fenfible note. In like manner, the chord *re fa fol※ fi*, or *fi re fa la♭ ut♭*, will belong to the minor mode of *mi♭*, and the chord *fa fol※ fi re*, or *fa la♭ ut♭ mi♭♭*, to the minor mode of *fol♭*.

After having paffed then by the mode of *la* to the chord *fol※ fi re fa* (art. 117.), one may by means of this laft chord, and by merely fatisfying ourfelves to invert it, afterwards pafs all at once to the modes of *ut* minor, of *mi♭* minor, or of *fol♭* minor; that is to fay, into the modes which have nothing, or almoft nothing, in common with the minor mode of *la*, and which are entirely foreign to it (†).

162 The alteration, however, by which it is effectuated, abrupt and fenfible.

146. It muft, however, be acknowledged, that a tranfition fo abrupt, and fo little expected, cannot deceive nor elude the ear; it is ftruck with a fenfation fo unlooked-for without being able to account for the paffage to itfelf. And this account has its foundation in the enharmonic fourth of a tone; which is overlooked as nothing, becaufe it is inappretiable by the ear; but of which, tho' its value is not afcertained, the whole harfhnefs is fenfibly perceived. The inftant of furprife, however, immediately vanifhes; and that aftonifhment is turned into admiration, when one feels himfelf tranfported as it were all at once, and almoft imperceptibly, from one mode to another, which is by no means relative to it, and to which he never could have immediately paffed by the ordinary feries of fundamental notes.

Chap. XX. *Of the Diatonic Enharmonic Species.*

147. If we form a fundamental bafs, which rifes alternately by fifths and thirds, as *fa*, *ut*, *mi*, *fi*, this bafs will give the following modulation, *fa*, *mi*, *mi*, *re※*; in which the femitones from *fa* to *mi*, and from *mi* to *re※*, are equal and major (NN). *See fig.* M.

This fpecies of modulation or of harmony, in which all the femitones are major, is called the *enharmonic diatonical* fpecies. The major femitones peculiar to this fpecies give it the name of *diatonic*, becaufe major femitones belong to the diatonic fpecies; and the tones which are greater than major by the excefs of a fourth, refulting from a fucceffion of major femitones, give it the name of *enharmonic* (note LL). *See Enharmonic.*

Chap. XXI. *Of the Chromatic Enharmonic Species.*

163 Chromatic enharmonic intervals, how formed.

148. If we pafs alternately from a third minor in defcending to a third major in rifing, as *ut*, *ut*, *la*, *ut※*, *ut※*, we fhall form this modulation *mi♭*, *mi*, *mi*, *mi*, *mi※*, in which all the femitones are minor (OO). *See fig.* N.

164 From this fpecies, the effects of harmony and melody appear to be in the fundamental bafs.

This fpecies is called the *chromatic enharmonical* fpecies: the minor femitones peculiar to this kind give it the name of *chromatic*, becaufe minor femitones belong to the chromatic fpecies; and the femitones which are leffer by the diminution of a fourth refulting from a fucceffion of minor femitones, give it the name of *enharmonic* (note LL).

149. Thefe new fpecies confirm what we have all along faid, that the whole effects of harmony and melody refide in the fundamental bafs.

165 Diatonic fpecies moft agreeable, and why.

150. The diatonic fpecies is the moft agreeable, becaufe

(†) As this method for obtaining or fupplying enharmonic gradations cannot be practifed on every occafion when the compofer or practitioner would wifh to find them, efpecially upon inftruments where the fcale is fixed and invariable, except by a total alteration of their œconomy, and re-tuning the ftrings, Dr Smith in his Harmonics has propofed an expedient for redreffing or qualifying this defect, by the addition of a greater number of keys or ftrings, which may divide the tone or femitone into as many appretiable or fenfible intervals as may be neceffary. For this, as well as for the other advantageous improvements which he propofes in the ftructure of inftruments, we cannot with too much warmth recommend the perufal of his learned and ingenious book to fuch of our readers as afpire to the character of genuine adepts in the theory of mufic.

(NN) It is obvious, that if *fa* in the bafs be fuppofed 1, *fa* of the fcale will be 2, *ut* of the bafs $\frac{3}{2}$, and *mi* of the fcale $\frac{5}{4}$ of $\frac{3}{2}$, that is, $\frac{15}{8}$; the proportion of *fa* to *mi* is as 2 to $\frac{15}{8}$, or as 1 to $\frac{15}{16}$. Now *mi* of the bafs being likewife $\frac{5}{4}$ of $\frac{3}{2}$, or $\frac{15}{8}$, *fi* of the bafs is $\frac{3}{2}$ of $\frac{15}{8}$, and its third major *re※* $\frac{5}{4}$ of $\frac{3}{2}$ of $\frac{15}{8}$, or $\frac{15}{8}$ of $\frac{15}{8}$; this third major, approximated as much as poffible to *mi* in the fcale by means of octaves, will be $\frac{15}{16}$ of $\frac{15}{8}$: *mi* then of the fcale will be to *re※* which follows it, as $\frac{15}{8}$ is to $\frac{15}{16}$ of $\frac{15}{8}$, that is to fay, as 1 to $\frac{15}{16}$. The femitones then from *fa* to *mi*, and from *mi* to *re※*, are both major.

(OO) It is evident that *mi♭* is $\frac{6}{5}$ (note C), and that *mi* is $\frac{5}{4}$: thefe two *mi*'s, then, are between themfelves as $\frac{6}{5}$ to $\frac{5}{4}$, that is to fay, as 6 times 4 to 5 times 5, or as 24 to 25, the interval which conftitutes the minor femitone. Moreover, the *la* of the bafs is $\frac{5}{6}$, and *ut※* $\frac{5}{4}$ of $\frac{5}{6}$, or $\frac{25}{24}$: *mi※* then is $\frac{5}{4}$ of $\frac{25}{24}$, the *mi* in the fcale is likewife to the *mi※* which follows it, as 24 to 25. All the femitones therefore in this fcale are minor.

Theory of Harmony.

because the fundamental bafs which produces it is formed from a fucceffion of fifths alone, which is the moft natural of all others.

166 The chromatic next. 151. The chromatic being formed from a fucceffion of thirds, is the moft natural after the preceding.

167 Laftly, the enharmonic. 152. Finally, the enharmonic is the leaft agreeable of all, becaufe the fundamental bafs which gives it is not immediately indicated by nature. The fourth of a tone which conftitutes this fpecies, and which is itfelf inappretiable to the ear, neither produces nor can produce its effect, but in proportion as imagination fuggefts the fundamental bafs from whence it refults; a bafs whofe procedure is not agreeable to nature, fince it is formed of two founds which are not contiguous one to the other in the feries of thirds (art. 144.)

Chap. XXII. *Showing that Melody is the Offspring of Harmony.*

168 The effects of melody to be inveftigated in harmony expreffed or underftood. 153. All that we have hitherto faid, as it feems to me, is more than fufficient to convince us, that melody has its original principle in harmony; and that it is in harmony, expreffed or underftood, that we ought to look for the effects of melody.

154. If this fhould ftill appear doubtful, nothing more is neceffary than to pay due attention to the firft experiment (art 19.), where it may be feen that the principal found is always the loweft, and that the fharper founds which it generates are with relation to it what the treble of an air is to its bafs.

155. Yet more, we have proved, in treating of broken cadence (Chap. xvii.), that the diverfification of baffes produces effects totally different in a modulation which, in other refpects, remains the fame.

156. Can it be ftill neceffary to adduce more convincing proofs? We have nothing to do but examine the different baffes which may be given to this very fimple modulation *fol ut;* of which it will be found fufceptible of a great many, and each of thefe baffes will give a different character to the modulation *fol ut*, though in itfelf it remains always the fame; in fuch a manner that we may change the whole nature and effects of a modulation, without any other alteration except that of changing its fundamental bafs.

M. Rameau has fhown, in his *New Syftem of Mufic*, printed at Paris 1726, *p.* 44. that this modulation *fol ut*, is fufceptible of 20 different fundamental baffes. Now the fame fundamental bafs, as may be feen in our fecond part, will afford feveral continued or thorough baffes. How many means, of confequence, may be practifed to vary the expreffion of the fame modulation?

169 Confequences deducible from this principle. 157. From thefe different obfervations it may be concluded, 1. That an agreeable melody, naturally implies a bafs extremely fweet and adapted for finging; and that reciprocally, as muficians exprefs it, a bafs of this kind generally prognofticates an agreeable melody (pp).

2. That the character of a juft harmony is only to form in fome meafure one fyftem with the modulation, fo that from the whole taken together the ear may only receive, if we may fpeak fo, one fimple and indivifible impreffion.

3. That the character of the fame modulation may be diverfified, according to the character of the bafs which is joined with it.

But notwithftanding the dependency of melody upon harmony, and the fenfible influence which the latter may exert upon the former; we muft not however from thence conclude, with fome celebrated muficians, that the effects of harmony are preferable to thofe of melody. Experience proves the contrary. [See, on this account, what is written on the licence of mufic, printed in tom. iv. of D'Alembert's *Melanges de Literature*, p. 448.]

General Remark.

The diatonic fcale or gammut being compofed of twelve femitones, it is clear that each of thefe femitones taken by itfelf may be the generator of a mode; and that thus there muft be twenty-four modes in all, twelve major and twelve minor. We have affumed the major mode of *ut*, to reprefent all the major modes in general, and the minor mode of *la* to reprefent the modes minor, to avoid the difficulties arifing from fharps and flats, of which we muft have encountered either a greater or leffer number in the other modes. But the rules we have given for each mode are general, whatever note of the gammut be taken for the generator of a mode.

Part II. Principles and Rules of COMPOSITION.

170 Compofition in harmony, what. See *Compofition*. 158. Composition, which is likewife called *counterpoint*, is not only the art of compofing an agreeable air, but alfo that of compofing a great many airs in fuch a manner that when heard at the fame time, they may unite in producing an effect agreeable and delightful to the ear; this is what we call *compofing mufic in feveral parts*.

The higheft of thefe parts is called the *treble*, the loweft is termed the *bafs;* the other parts, when there are any, are termed *middle parts;* and each in particular is fignified by a different name.

Chap. I. *Of the Different Names given to the fame Interval.*

171 Particular intervals fignified by different names, and why. 159. In the introduction (art. 9.), which is at the front of this treatife, we have feen a detail of the moft common names which are given to the different intervals. But there are particular intervals which have obtained different names, according to particular circumftances; which it is proper to explain.

172 Second redundant, what. 160. An interval compofed of a tone and a femitone, which is commonly called a *third minor*, is likewife

(pp) There are likewife feveral eminent muficians, who in their compofitions, if we can depend on what has been affirmed, begin with determining and writing the bafs. See *l'Encyclopédie*, tom. 7. p. 61. This method, however, appears in general more proper to produce a learned and harmonious mufic, than a ftrain prompted by genius and animated by enthufiafm.

Principles of Compoſition. wiſe ſometimes called a *ſecond redundant;* ſuch is the interval from *ut to re*※ in aſcending, or that of *la* to *ſol*♭ deſcending.

173 Why ſo called. This interval is ſo termed, becauſe one of the ſounds which form it is always either ſharp or flat, and that, if you deduce that ſharp or that flat, the interval will be that of a ſecond.

174 Falſe fifth, what. 161. An interval compoſed of two tones and two ſemitones, as that from *ſi* to *fa*, is called a *falſe fifth.* This interval is the ſame with the *triton* (art. 9.), ſince two tones and two ſemitones are equivalent to three tones. There are, however, ſome reaſons for diſtinguiſhing them, as will appear below.

175 Fifth redundant, what. 162. As the interval from *ut* to *re*※ in aſcending, has been called a ſecond redundant, they likewiſe call the interval from *ut* to *ſol*※ in aſcending a *fifth redundant*, or from *ſi* to *mi*♭ in deſcending, each of which intervals are compoſed of four tones.

176 Diſtinguiſhed from the ſixth minor. This interval is, in the main, the ſame with that of the ſixth minor (art. 9.): but in the fifth redundant there is always a ſharp or a flat; inſomuch, that if this ſharp or flat were deduced, the interval would become a true fifth.

177 Seventh diminiſhed, what. 163. For the ſame reaſon, an interval compoſed of three tones and three ſemitones, as from *ſol*※ to *fa* in aſcending, is called a *ſeventh diminiſhed;* becauſe, if you deduced the ſharp from *ſol*, the interval from *ſol* to *fa* will become that of an ordinary ſeventh. The interval of a ſeventh diminiſhed is in other reſpects the ſame with that of the ſixth major (art. 9.)

178 Seventh major and redundant coincident. 164. The major ſeventh is likewiſe ſometimes called a *ſeventh redundant* (QQ.)

CHAP. II. *Compariſon of the Different Intervals.*

179 Notes in different octaves or ſcales replications each of the other. 165. IF we ſing *ut ſi* in deſcending by a ſecond, and afterwards *ut ſi* in aſcending by a ſeventh, theſe two *ſi*'s ſhall be octaves one to the other; or, as we commonly expreſs it, they will be *replications* one of the other.

180 Hence to deſcend to one replication, and riſe to another, has the ſame effect. 166. On account then of the reſemblance between every ſound and its octave (art. 22.), it follows, that *to riſe by a ſeventh*, or *deſcend by a ſecond*, amount to one and the ſame thing.

167. In like manner, it is evident that the ſixth is nothing but a replication of the third, nor the fourth but a replication of the fifth.

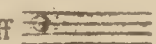
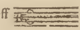
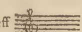
181 Detail of replications. 168. The following expreſſions either are, or ought to be, regarded as ſynonimous.

182 Examples of this.

To riſe	by a ſecond.	To deſcend	by a ſeventh.
To deſcend		To riſe	
To riſe	by a third.	To deſcend	by a ſixth.
To deſcend		To riſe	
To riſe	by a fourth.	To deſcend	by a fifth.
To deſcend		To riſe	

169. Thus, therefore, we ſhall employ them indifferently the one for the other; ſo that when we ſay, for inſtance, *to riſe by a third*, it may be ſaid with equal propriety *to deſcend by a ſixth*, &c.

CHAP. III. *Of the different Cleffs; of the Value or Quantity; of the Rithmus; and of Syncopation.*

183 Cleffs, what. 170. THERE are three cleffs * in muſic; the cleff of *fa* , or ; the cleff of *ut* ; and the cleff of *ſol* . But, in Britain, the following characters are uſed: The F, or baſs-cleff ; the C, or tenor cleff ; and the G, or treble cleff .

184 And how placed. The cleff of *fa* is placed on the fourth line, or on the third; and the line upon which this cleff is placed gives the name of *fa*, or *F*, to all the notes which are upon that line. See fig. O.

The cleff of *ut* is placed upon the fourth, the third, the ſecond, or the firſt line; and in theſe different poſitions all the notes upon that line where the cleff is placed take the name of *ut*, or *C*. See fig. P.

Laſtly, the cleff of *ſol* is placed upon the ſecond or firſt line; and all the notes upon that line where the cleff is placed take the name of *ſol*, or G. See fig. Q.

185 Names of notes to be inveſtigated from the poſition of the cleffs. 171. As the notes are placed on the lines, and in the ſpaces between the lines, any one, when he ſees the cleff, may eaſily find the name of any note whatever. Thus he may ſee, that, in the firſt cleff of *fa*, the note which is placed on the loweſt line ought to be *ſol;* that the note which occupies the ſpace between the two firſt lines ſhould be *la;* and that the note which is on the ſecond line is a *ſi*, &c. (RR). See fig. O.

* See *Cleff.*

(QQ.) The chief uſe of theſe different denominations is to diſtinguiſh chords: for inſtance, the chord of the redundant fifth and that of the diminiſhed ſeventh, are different from the chord of the ſixth; the chord of the ſeventh redundant from that of the ſeventh major. This will be explained in the following chapters.

(RR) It is on account of the different compaſſes of voices and inſtruments that theſe cleffs have been invented.

The maſculine voice, which is the loweſt, may at its greateſt depth, without ſtraining, deſcend to *ſol*, which is in the laſt line of the firſt cleff of *fa;* and the female voice, which is the ſharpeſt, may at its higheſt pitch riſe to a *ſol*, which is a triple octave above the former.

The loweſt of maſculine voices is adapted to a part which may be called a *mean baſs*, and its cleff is that of *fa* on the fourth line; this cleff is likewiſe that of the violoncello and of the deepeſt inſtruments. A mean baſs extremely deep is called a *baritonus* or *counter-baſs*.

The maſculine voice, which is next in depth to what we have called the *mean baſs*, may be termed the *concordant baſs*. Its cleff is that of *fa* on the third line.

The maſculine voice which follows the *concordant baſs* may be denominated a *tenor;* a voice of this pitch is the moſt common, yet ſeldom extremely agreeable. Its cleff is that of *ut* on the fourth line. This cleff is alſo that of the baſſoon or baſs hautboy.

The higheſt maſculine voice of all may be called *counter tenor*. Its cleff is that of *ut* on the third line. It is likewiſe the cleff of tenor violins, &c.

172. A

The

Principles of Composition.

172. A note before which there is a ſharp (marked thus ✳) ought to be raiſed by a ſemitone; and if, on the contrary, there is a ♭ before it, it ought to be depreſſed by a ſemitone, (♭ being the mark of a flat).

186 Marks and powers of ſharps, flats, and naturals, what.

The natural (marked thus ♮) reſtores to its natural value a note which had been raiſed or depreſſed by a ſemitone.

173. When you place at the cleff a ſharp or a flat, all the notes upon the line on which this ſharp or flat is marked are ſharp or flat. Thus let us take, for inſtance, the cleff of *ut* upon the firſt line, and let us place a ſharp in the ſpace between the ſecond and third line, which is the place of *fa*; all the notes which ſhall be marked in that ſpace will be *fa*✳; and if you would reſtore them to their original value of *fa* natural, you muſt place a ♮ or a ♭ before them. See fig. R. See fig. S.

In the ſame manner, if a flat be marked at the cleff, and if you would reſtore the note to its natural ſtate, you muſt place a ♮ or a ✳ before it. See fig. X.

187 Bars and times, what.

174. Every piece of muſic is divided into different equal times, which they call *meaſures* or *bars;* and each bar is likewiſe divided into different times.

There are properly two kinds of meaſures or modes of time (*See* T): the meaſure of two times, or of common time, which is marked by the figure 2 placed at the beginning of the tune; and the meaſure of three times, or of triple time, which is marked by the figure 3 placed in the ſame manner. (*See* V). See *Time.*

The different bars are diſtinguiſhed by perpendicular lines.

In a bar we diſtinguiſh between the *perfect* and *imperfect* time; the *perfect* time is that which we *beat*, the *imperfect* that in which we *lift up the hand or foot*. A bar conſiſting of four times ought to be regarded as compounded of two bars, each conſiſting of two times: thus there are in this bar two perfect and two imperfect times. In general, by the words *perfect* and *imperfect*, even the parts of the ſame time are diſtinguiſhed: thus the firſt note of each time is reckoned as belonging to the *perfect* part, and the others as belonging to the *imperfect*. See fig. Y.

188 The value of notes in duration.

175. The longeſt of all notes is a ſemibreve. A minim is half its value; that is to ſay, in ſinging, we only employ the ſame duration in performing two minims which was occupied in one ſemibreve. A minim in the ſame manner is equivalent to two crotchets, the crotchet to two quavers, &c.

189 Syncopation, what.

176. A note which is divided into two parts by a time, that is to ſay, which begins at the end of a time, and terminates in the time following, is called (ss) a *ſyncopated note*. (*See* Z; where the notes *ut*, *ſi*, and *la*, are each of them ſyncopated.) (†). See *Syncopation.*

[f 2] 177. A

The deepeſt female voice immediately follows the counter tenor, and may be called *baſs in alt*. Its cleff is that of *ut* upon the firſt line. The cleff of *ut* upon the ſecond line is not in frequent uſe.

The ſharpeſt female voice is called *treble;* its cleff is that of *ſol* on the ſecond line.

This laſt cleff, as well as that of *ſol* on the firſt line, is likewiſe the cleff of the ſharpeſt inſtruments, ſuch as the violin, the flute, the trumpet, the hautboy, the flagelet, &c.

The *ut* which may be ſeen in the cleffs of *fa* and in the cleffs of *ut* is a fifth above the *fa* which is on the line of the cleff of *fa;* and the *ſol* which is on the two cleffs of *ſol* is a fifth above *ut:* inſomuch that *ſol* which is on the loweſt line of the firſt cleff of *fa*, is lower by two whole octaves than the *ſol* which is on the loweſt line of the ſecond cleff of *ſol*.

[Thus far the tranſlator has followed his original as accurately as poſſible; but this was by no means an eaſy taſk. Among all the writers on muſic which he has found in Engliſh, there is no ſuch thing as different names for each particular part which is employed to conſtitute full or complete harmony. He was therefore under a neceſſity of ſubſtituting by analogy ſuch names as appeared moſt expreſſive of his author's meaning. To facilitate this attempt, he examined in Rouſſeau's muſical dictionary the terms by which the different parts were denominated in D'Alembert; but even Rouſſeau, with all his depth of thought and extent of erudition, inſtead of expreſſing himſelf with that preciſion which the ſubject required, frequently applies the ſame names indiſcriminately to different parts, without aſſigning any reaſon for this promiſcuous and licentious uſe of words. The Engliſh reader therefore will be beſt able to form an accurate idea of the different parts, by the nature and ſituation of the cleffs with which they are marked; and if he ſhould find any impropriety in the names which are given them, he may adopt and aſſociate others more agreeable to his ideas.]

(ss) Syncopation conſiſts in a note which is protracted in two different times belonging partly to the one and partly to the other, or in two different bars; yet not ſo as entirely to occupy or fill up the two times, or the two bars. A note, for inſtance, which begins in the imperfect time of a bar, and which ends in the perfect time of the following, or which in the ſame bar begins in the imperfect part of one time and ends in the perfect of the following, is ſyncopated. A note which of itſelf occupies one or two bars, whether the meaſure conſiſts of two or three times, is not conſidered as ſyncopated: this is a conſequence of the preceding definition. This note is ſaid to be *continued* or *protracted*. In the end of the example Z, the *ut* of the firſt bar conſiſting of three times is not ſyncopated, becauſe it occupies two whole times. It is the ſame caſe with *mi* of the ſecond bar, and with the *ut* of the fourth and fifth. Theſe therefore are continued or protracted notes.

(†) *Times* and *bars* in muſic anſwer the very ſame end as punctuation in language. They determine the different periods of the movement, or the various degree of completion, which the ſentiment, expreſſed by that movement, has attained. Let us ſuppoſe, for inſtance, a compoſer in muſic intending to expreſs grief or joy, in all its various gradations, from its firſt and fainteſt ſenſation, to its acme or higheſt poſſible degree. We do not ſay that ſuch a progreſs of any paſſion either has been or can be delineated in practice, yet it may ſerve to illuſtrate what we mean to explain. Upon this hypotheſis, therefore, the degrees of the ſentiment will paſs from leſs to more ſenſible, as it riſes to its moſt intenſe degree. The firſt of theſe gradations may be called a *time*

177. A note followed by a point or dot is increased half its value. The *ſi*, for inſtance, in the fifth bar of the example Y, followed by a point, has the va-
190 lue (*) or duration of a minim and of a crotchet at the ſame time.

190 Value of a pointed note.

Chap. IV. *Containing a Definition of the principal Chords.*

191 Perfect chords, what.

178. The chord compoſed of a third, a fifth, and an octave, as *ut mi ſol ut*, is called a *perfect chord* (art. 32).

If the third be major, as in *ut mi ſol ut*, the perfect chord is denominated *major:* if the third be minor, as in *la ut mi la*, the perfect chord is minor. The perfect chord major conſtitutes what we call the *major mode;* and the perfect chord minor, what we term the *minor mode* (art. 31).

192 Chord of the ſeventh, what, and how to be practiſed.

179. A chord compoſed of a third, a fifth, and a ſeventh, as *ſol ſi re fa*, or *re fa la ut*, &c. is called a *chord of the ſeventh*. It is obvious that ſuch a chord is wholly compoſed of thirds in aſcending.

All chords of the ſeventh are practiſed in harmony, ſave that which might carry the third minor and the ſeventh major, as *ut mi♭ ſol ſi;* and that which might carry a falſe fifth and a ſeventh major, as *ſi re fa la*✱. (chap. xiv. Part I.).

193 Thoſe of different kinds.

180. As thirds are either major or minor, and as they may be differently arranged, it is clear that there are different kinds of chords of the ſeventh; there is even one, *ſi re fa la*, which is compoſed of a third, a falſe fifth, and a ſeventh.

194 Of the greater ſixth, what.

181. A chord compoſed of a third, a fifth, and a ſixth, as *fa la ut re*, *re fa la ſi*, is called a *chord of the greater ſixth*.

195 Tonic, what, and its chords, how figured.

182. Every note which carries a perfect chord is called a *tonic*, and the perfect chord is marked by an 8, by a 3, or by a 5, which is written above the note; but frequently theſe numbers are ſuppreſſed. Thus in the example I. the two *ut*'s equally carry a perfect chord.

196 Dominant, what, and how figured.

183. Every note which carries a chord of the ſeventh is called a *dominant* (art. 102); and this chord is marked by a 7 written above the note. Thus in the example II. *re* carries the chord *re fa la ut*, and *ſol* the chord *ſol ſi re fa*.

It is neceſſary to remark, that among the chords of the ſeventh we do not reckon the chord of the ſeventh diminiſhed, which is only improperly called a *chord of the ſeventh:* and of which we ſhall ſay more below.

197 Sub-dominant, what, and how figured.

184. Every note which carries the chord of the great ſixth, is called a *ſub-dominant*, (art 97, and 42.) and is marked with a 6. Thus in the example III. *fa* carries the chord of *fa la ut re*. You ought to remark that the ſixth ſhould always be major, (art. 97, and 109).

198 Fundamental note, what. See *Fundamental.*

185. In every chord, whether perfect, or a chord of the ſeventh, or of the great ſixth, the note which carries this chord, and which is the flatteſt or loweſt, is called the *fundamental note*. Thus *ut* in the example I. *re* and *ſol* in the example II. and *fa* in the example III. are fundamental notes.

199 Diſſonance of a chord, what.

186. In every chord of the ſeventh, and of the great ſixth, the note which forms the ſeventh or ſixth above the fundamental, that is to ſay, the higheſt note of the chord, is called a *diſſonance*. Thus in the chords

time, which is likewiſe the moſt convenient diviſion of a bar or meaſure into its elementary or aliquot parts, and may be deemed equivalent to a comma in a ſentence; a bar denotes a degree ſtill more ſenſible, and may be conſidered as having the force of a ſemicolon; a ſtrain brings the ſentiment to a tolerable degree of perfection, and may be reckoned equal to a colon: the full period is the end of the imitative piece. It muſt have been remarked by obſervers of meaſure in melody or harmony, that the notes of which a bar or meaſure conſiſts, are not diverſified by their different durations alone, but likewiſe by greater or leſſer degrees of emphaſis. The moſt emphatic parts of a bar are called the *accented parts;* thoſe which require leſs energy in expreſſion are called the *unaccented*. The ſame obſervation holds with regard to times as bars. The ſtroke, therefore, of the hand or foot in beating marks the accented part of the bar, the elevation or preparation for the ſtroke marks the unaccented part. Let us once more reſume our compoſition intended to expreſs the different periods in the progreſs of grief or joy. There are ſome revolutions in each of theſe ſo rapid as not to be marked by any ſenſible tranſition whether diatonic or conſonant. In this caſe, the moſt expreſſive tone may be continued from one part of a time or meaſure to another, and end before the period of that time or meaſure in which it begins. Here therefore is a natural principle upon which the practice of ſyncopation may be founded even in melody: but when muſic is compoſed in different parts to be ſimultaneouſly heard, the continuance of one note not divided by regular times and meaſures, nor beginning and ending with either of them, whilſt the other parts either aſcend or deſcend according to the regular diviſions of the movement, has not only a ſenſible effect in rendering the imitation more perfect, but even gives the happieſt opportunities of diverſifying the harmony, which of itſelf is a moſt delightful perception.

For the various diſpoſitions of accent in times and meaſures, according to the movement of any piece, ſee a Treatiſe on Muſic by Alexander Malcolm.

For the opportunities of diverſifying harmony afforded by ſyncopation, ſee Rameau's Principles of Compoſition.

(*) To prevent ambiguity or confuſion of ideas, it is neceſſary to inform our readers, that we have followed M. D'Alembert in his double ſenſe of the word *value*, though we could have wiſhed he had diſtinguiſhed the different meanings by different words. A ſound may be either eſtimated by its different degrees of intenſeneſs, or by its different quantities of duration.

To ſignify both thoſe ideas the word *value* is employed by D'Alembert. The reader, therefore, will find it of importance to diſtinguiſh the value of a note in height from its value in duration. This he may eaſily do, by conſidering whether the notes are treated as parts of the diatonic ſcale, or as continued for a greater or leſſer duration.

Principles of Compoſition.

chords of the ſeventh *ſol ſi re fa, re fa la ut, fa* and *ut* are the diſſonances, viz. *fa* with relation to *ſol* in the firſt chord, and *ut* with relation to *re* in the ſecond. In the chord of the great ſixth *fa la ut re, re* is the diſſonance (art. 120.); but that *re* is only, properly ſpeaking, a diſſonance with relation to *ut* from which it is a *ſecond*, and not with reſpect to *fa* from which it is a *ſixth major* (art. 17, and 18).

200 Tonic and ſimple dominant, what.

187. When a chord of the ſeventh is compoſed of a third major followed by two thirds minor, the fundamental note of this chord is called the *tonic dominant*. In every other chord of the ſeventh the fundamental is called the *ſimple dominant*, (art. 102.) Thus in the chord *ſol ſi re fa*, the fundamental *ſol* is the *tonic dominant*; but in the other chords of the ſeventh, as *ut mi ſol ſi, re fa la ut*, &c. the fundamentals *ut* and *re* are *ſimple dominants*.

201 Major chords, how rendered minor, and *vice verſa*.

188. In every chord, whether perfect, or of the ſeventh, or of the ſixth, if you have a mind that the third above the fundamental note ſhould be major, though it is naturally minor, you muſt place a ſharp above the fundamental note. For example, if I would mark the perfect major chord *re fa※ la re*, as the third *fa* above *re* is naturally minor, I place above *re* a ſharp, as you may ſee in example IV. In the ſame manner the chord of the ſeventh *re fa※ la ut*, and the chord of the great ſixth *re fa※ la ſi*, is marked with a ※ above *re*, and above the ※ a 7 or a 6, (ſee V. and VI.).

On the contrary, when the third is naturally major, and if you ſhould incline to render it minor, you muſt place above the fundamental note a ♭. Thus the examples VII. VIII. IX. ſhew the chords *ſol ſi♭ re ſol, ſol ſi♭ re fa, ſol ſi♭ re mi*, (TT).

Chap. V. *Of the Fundamental Baſs.*

202 Fundamental baſs, how formed.

189. Invent a modulation at your pleaſure; and under this modulation let there be ſet a baſs compoſed of different notes, of which ſome may carry a perfect chord, others that of the ſeventh, and others that of the great ſixth, in ſuch a manner that each note of the modulation which anſwers to each of the baſs, may be one of thoſe which enters into the chord of that note in the baſs; this baſs being compoſed according to the rules which ſhall be immediately given, will be the *fundamental baſs* of the modulation propoſed. See Part I. where *the nature and principles of the fundamental baſs* are explained.

See Fundamental baſs.

Thus (Exam. XVIII.) you will find that this modulation, *ut re mi fa ſol la ſi ut*, has or may admit for its fundamental baſs, *ut* $\overset{7}{\textit{ſol}}$ *ut* $\overset{6}{\textit{fa}}$ *ut* $\overset{7}{\textit{re}}$ $\overset{7}{\textit{ſol}}$ *ut*.

In reality, the firſt note *ut* in the upper-part is found in the chord of the firſt note *ut* in the baſs, which chord is *ut mi ſol ut*; the ſecond note *re* in the treble is found in the chord *ſol ſi re fa*, which is the chord of the ſecond note in the baſs, &c. and the baſs is compoſed only of notes which carry a perfect chord, or that of the ſeventh, or that of the great ſixth. Moreover, it is formed according to the rules which we are now about to give.

Chap. VI. *Rules for the Fundamental Baſs.*

203 Rules for the formation of this baſs.

190. All the notes of the fundamental baſs being only capable of carrying a perfect chord, or the chord of the ſeventh, or that of the great ſixth, are either tonics, or dominants, or ſub-dominants; and the dominants may be either ſimple or tonic.

The fundamental baſs ought always to begin with a tonic, as much as it is practicable. And now follow the rules for all the ſucceeding chords; rules which are evidently derived from the principles eſtabliſhed in the *Firſt Part* of this treatiſe. To be convinced of this, we ſhall find it only neceſſary to review the articles 34, 91, 122, 124, 126, 127.

Rule I.

191. In every chord of the tonic, or of the tonic dominant, it is neceſſary that at leaſt one of the notes which form that chord ſhould be found in the chord that precedes it.

Rule II.

192. In every chord of the ſimple dominant, it is neceſſary that the note which conſtitutes the ſeventh, or

(TT) We may only add, that there is no occaſion for marking theſe ſharps or flats when they are originally placed at the cleff. For inſtance, if the ſharp be upon the cleff of *fa* (ſee Exam. X.), one may ſatisfy himſelf with ſimply writing *re*, without a ſharp to mark the perfect chord major of *re, re fa※ la re*. In the ſame manner, in the Example XI. where the flat is at the cliff upon *ſi*, one may ſatisfy himſelf with ſimply writing *ſol*, to mark the perfect chord minor of *ſol ſi♭ re ſol*.

But if a caſe occurs where there is a ſharp or a flat at the cleff, if any one ſhould wiſh to render the chord minor which is major, or *vice verſa*, he muſt place above the fundamental note a ♮, or natural. Thus the Example XII. marks the minor chord *re fa la re*, and Example XIII. the major chord *ſol ſi re ſol*.—Frequently, in lieu of a natural, a flat is uſed to ſignify the minor chord, and a ſharp to ſignify the major. Thus Example XIV. marks the minor chord *re fa la re*, and Example XV. the major chord *ſol ſi re ſol*.

When in a chord of the great ſixth, the diſſonance, that is to ſay, the ſixth, ought to be ſharp, and when the ſharp is not found at the cleff, they write before or after the 6 a ※; and if this ſixth ſhould be flat according to the cleff, they write a ♮.

In the ſame manner, if in a chord of the ſeventh of the tonic dominant, the diſſonance, that is to ſay, the ſeventh, ought to be flat or natural, they write by the ſide of the ſeventh a ♭ or a ♮. Many muſicians, when a ſeventh from the ſimple dominant ought to be altered by a ſharp or a natural, have likewiſe written by the ſide of the ſeventh a ※ or a ♮; but M. Rameau ſuppreſſes theſe characters. The reaſon ſhall be given below, when we ſpeak of chords by ſuppoſition.

If there be a ſharp on the cleff of *fa*, and if I ſhould incline to mark the chord *ſol ſi re fa*, or the chord *la ut mi fa*, I would place before the ſeventh or the ſixth a ♮ or a ♭.

In the ſame manner, if there be a flat on the cleff at *ſi*, and if I ſhould incline to mark the chord *ut mi ſol ſi*, I would place before the ſeventh a ※ or a ♮, and ſo of the reſt.

or dissonance, should likewise be found in the preceding chord.

RULE III.

193. In every chord of the sub-dominant, at least one of its consonances must be found in the preceding chord. Thus, in the chord of the sub-dominant *fa la ut re*, it is necessary that *fa*, *la*, or *ut*, which are the consonances of the chord, should be found in the chord preceding. The dissonance *re* may either be found in it or not.

RULE IV.

194. Every simple or tonic dominant ought to descend by a fifth. In the first case, that is to say, when the dominant is simple, the note which follows can only be a dominant; in the second it may be any one you choose; or, in other words, it may either be a tonic, a tonic dominant, a simple dominant, or a sub-dominant. It is necessary, however, that the conditions prescribed in the second rule should be observed, if it be a simple dominant.

This last reflection is necessary, as you will presently see. For let us assume the succession of the two chords *la ut♯ mi sol, re fa la ut*, (see Exam. XIX.) this succession is by no means legitimate, though in it the first dominant descends by a fifth; because the *ut* which forms the dissonance in the second chord, and which belongs to a simple dominant, is not in the preceding chord. But the succession will be admissible, if, without meddling with the second chord, one should take away the sharp carried by the *ut* in the first; or if, without meddling with the first chord, one should render *ut* or *fa* sharp in the second (UU); or in short, if one should simply render the *re* of the second chord a tonic dominant, in causing it to carry *fa♯* instead of *fa* natural (119. & 122.).

It is likewise by the same rule that we ought to reject the succession of the two following chords,

re fa la ut, sol si re fa♯;

(see Exam. XX.).

RULE V.

195. Every sub-dominant ought to rise by a fifth; and the note which follows it may, at your pleasure, be either a tonic, a tonic dominant, or a sub-dominant.

REMARK.

204 Other rules substituted.

Of the five fundamental rules which have now been given, instead of the three first, one may substitute the three following, which are nothing but consequences from them, and which you may pass unnoticed if you think it proper.

RULE I.

If a note of the fundamental bass be a tonic, and rise by a fifth or a third to another note, that second note may be either a *tonic*, (34. & 91.) see Examples XXI. and XXII. (XX); a *tonic dominant*, (124.) see XXIII. and XXIV.; or a *sub dominant*, (124.) see XXV. and XXVI.; or, to express the rule more simply, that second note may be any one you please, except a *simple dominant*.

RULE II.

If a note of the fundamental bass be a tonic, and descend by a fifth or a third upon another note, this second note may be either a tonic, (34. & 91.) see Exam. XXVII. and XXVIII.; or a tonic dominant, or a simple dominant, yet in such a manner that the rule of art. 192. may be observed, (124.) see XXIX. XXX. XXXI. XXXII.; or a sub-dominant (124.), see XXXIII. and XXXIV.

The procedure of the bass *ut mi♭ sol ut, fa la ut mi*, from the tonic *ut* to the dominant *fa* (Ex. XXXV.), is excluded by art. 192.

RULE III.

If a note in the fundamental bass be a tonic, and rise by a second to another note, that note ought to be a tonic dominant, or a simple dominant (101. & 102.). See XXXVI. and XXXVII. (YY).

We must here advertise our readers, that the examples XXXVIII. XXXIX. XL. XLI. belong to the fourth rule above, art. 194.; and the examples XLII. XLIII. XLIV. to the fifth rule above, art. 195. See the articles 34, 35, 121, 123, 124.

REMARK I.

205 Perfect and imperfect cadences, what, and how employed.

196. The transition from a tonic dominant to a tonic is called an *absolute repose*, or a *perfect cadence* (73); and the transition from a sub-dominant to a tonic is called an *imperfect* or *irregular cadence* (73); the cadences are formed at the distance of four bars one from another, whilst the tonic then falls within the first time of the bar. See XLV. and XLVI.

REMARK II.

206 Syncopation only admissible in the fundamental bass by licence.

197. We must avoid as much as we can, syncopations in the fundamental bass; that, within the first time of which a bar is constituted, the ear may be entertained with a harmony different from that which it had before perceived in the last time of the preceding bar.

(UU) In this chord it is necessary that the *ut* and *fa* should be sharp at the same time; for the chord *re fa la ut♯*, in which *ut* would be sharp without the *fa*, is excluded by art. 179.

(XX) When the bass rises or descends from one tonic to another by the interval of a third, the mode is commonly changed; that is to say, from a major it becomes a minor. For instance, if I ascend from the tonic *ut* to the tonic *mi*, the major mode of *ut*, *ut mi sol ut*, will be changed into the minor mode of *mi*, *mi sol si mi*. For what remains, we must never ascend from one tonic to another, when there is no sound common to both their modes; for example, you cannot rise to the mode of *ut*, *ut mi sol ut*, from the minor mode of *mi♭*, *mi♭ sol♭ si♭ mi♭* (91.).

(YY) By this we may see, that all the intervals, viz. the third, the fifth, and second, may be admitted in the fundamental bass, except that of a second in descending. For what remains, it is very proper to remark, that the rules immediately given for the fundamental bass are not without exception, as approved compositions in music will certainly discover; but these exceptions being in reality licences, and for the most part in opposition to the great principle of connection, which prescribes that there should be at least one note in common between a preceding and a subsequent chord, it does not seem necessary to entertain initiates with a minute detail of these licences in an elementary work, where the first and most essential rules of the art alone ought to be expected.

Principles of Compoſition.

bar. Nevertheleſs, ſyncopation may be ſometimes admitted in the fundamental baſs, but it is by a licence (ZZ).

CHAP. VII. *Of the Rules which ought to be obſerved in the Treble with relation to the Fundamental Baſs.*

207 Definition of treble.

198. THE treble is nothing elſe but a modulation above the fundamental baſs, and whoſe notes are found in the chords of that baſs which correſponds with it, (189.) Thus in Ex. XVIII. the ſcale *ut re mi fa ſol la ſi ut*, is a treble with reſpect to the fundamental baſs *ut ſol ut fa ut re ſol ut.*

208 One note in the treble or baſs may anſwer to ſeveral of its correſpondent parts, and why.

199. We are juſt about to give the rules for the treble; but firſt we think it neceſſary to make the two following remarks.

1. It is obvious, that many notes of the treble may anſwer to one and the ſame note in the fundamental baſs, when theſe notes belong to the chord of the ſame note in the fundamental baſs. For example, this modulation *ut mi ſol mi ut*, may have for its fundamental baſs the note *ut* alone, becauſe the chord of that note comprehends the ſounds *ut*, *mi*, *ſol*, which are found in the treble.

2. In like manner, a ſingle note in the treble may, for the ſame reaſon, anſwer to ſeveral notes in the baſs. For inſtance, *ſol* alone may anſwer to theſe three notes in the baſs, *ut ſol ut* (AAA).

RULE I. *for the* TREBLE.

200. If the note which forms the ſeventh in a chord of the *ſimple dominant* is found in the treble, the note which precedes it muſt be the very ſame. This is what we call a *diſcord prepared* (122). For inſtance, let us ſuppoſe that the note of the fundamental baſe ſhall be *re*, bearing the chord of the ſimple dominant *re fa la ut*; and that this *ut*, which (art. 18. & 118.) is the diſſonance, ſhould be found in the treble; it is neceſſary that the note which goes before it in the treble ſhould likewiſe be an *ut*.

201. And it is requiſite to obſerve, that, according to the rules which we have given for the fundamental baſs, *ut* will always be found in the chord of that note in the fundamental baſs which precedes the ſimple dominant *re*. See XLVIII. XLIX. L. In the firſt example the diſſonance is *ut*, in the ſecond *ſol*, and in the third *mi*; and theſe notes are already in the preceding chord (BBB).

RULE II.

202. If a note of the fundamental baſs be a tonic dominant, or a ſimple dominant, and if the diſſonance be found in the treble, this diſſonance in the ſame treble ought to deſcend diatonically. But if the note of the baſs be a ſub-dominant, it ought to riſe diatonically. This diſſonance which riſes or deſcends diatonically, is what we have called a *diſſonance ſaved* or *reſolved* (129, 130.). See LII. LIII. LIV.

203. One

(ZZ) There are notes which may be found ſeveral times in the fundamental baſs in ſucceſſion with a different harmony. For inſtance, the tonic *ut*, after having carried the chord *ut mi ſol ut*, may be followed by another *ut* which carries the chord of the ſeventh, provided that this chord be the chord of the tonic dominant *ut mi ſol ſi♭*. See LXXII. In the ſame manner, the tonic *ut* may be followed by the ſame tonic *ut*, which may be rendered a *ſub-dominant*, by cauſing it to carry the chord *ut mi ſol la.* See LXXIII.

A dominant, whether tonic or ſimple, ſometimes deſcends or riſes upon one another by the interval of a tritone or falſe fifth. For example, the dominant *fa*, carrying the chord *fa la ut mi*, may be followed by another dominant *ſi*, carrying the chord *ſi re fa la*. This is a licence in which the muſician indulges himſelf, that he may not be obliged to depart from the ſcale in which he is; for inſtance, from the ſcale of *ut* to which *fa* and *ſi* belong. If one ſhould deſcend from *fa* to *ſi♭*, by the interval of a juſt fifth, he would then depart from that ſcale, becauſe *ſi♭* is no part of it.

(AAA) There are often in the treble ſeveral notes which may, if we chooſe, carry no chord, and be regarded merely as notes of paſſage, ſerving only to connect between themſelves the notes that do carry chords, and to form a more agreeable modulation. Theſe notes of paſſage are commonly quavers. See Exam. XLVII. in which this modulation *ut re mi fa ſol*, may be regarded as equivalent to this other, *ut mi ſol*, as *re* and *fa* are no more than notes of paſſage. So that the baſs of this modulation may be ſimply *ut ſol.*

When the notes are of equal duration, and arranged in a diatonic order, the notes which occupy the perfect part of each time, or thoſe which are accented, ought each of them to carry chords. Thoſe which occupy the imperfect part, or which are unaccented, are no more than more mere notes of paſſage. Sometimes, however, the note which occupies the imperfect part may be made to carry harmony; but the value of this note is then commonly increaſed by a point which is placed after it, which proportionably diminiſhes the continuance of the note that occupies the perfect time, and makes it paſs more ſwiftly.

When the notes do not move diatonically, they ought generally all of them to enter into the chord which is placed in the lower part correſpondent with theſe notes.

(BBB) There is, however, one caſe in which the ſeventh of a ſimple dominant may be found in a modulation without being prepared. It is when, having already employed that dominant in the fundamental baſs, its ſeventh is afterwards heard in the modulation, as long as this dominant may be retained. For inſtance, let us imagine this modulation,

	ut	*re*	*ut*	*ſi*	*ut*	*re*;
and this fundamental baſs,	*ut*	*re*^{7}		*ſol*^{7}	*ut*	*ſol*^{7}

(ſee Example LI.); the *re* of the fundamental baſs anſwers to the two notes *re ut* of the treble. The diſſonance *ut* has no need of preparation, becauſe the note *re*^{7} of the fundamental baſs having already been employed for the *re* which precedes *ut*, the diſſonance *ut* is afterwards preſented, below which the chord *re* may be preſerved, or *re fa la ut.*

203. One may likewise observe here, that, according to the rules for the fundamental bass which we have given, the note upon which the dissonance ought to descend or rise will always be found in the subsequent chord (CCC).

CHAP. VIII. *Of the Continued Bass, and its Rules.*

* See *Continued bass.*

209 Thorough-bass, what.

204. A CONTINUED* or thorough bass, is nothing else but a fundamental bass whose chords are *inverted.* We invert a chord when we change the order of the notes which compose it. For example, if instead of the chord *sol si re fa*, I should say *si re fa sol*, or *re fa sol si*, &c. the chord is inverted. Let us see then, in the first place, all the possible ways in which a chord may be inverted.

210 Chords inverted, how.

The ways in which a PERFECT CHORD *may be* INVERTED.

205. The perfect chord *ut mi sol ut* may be inverted in two different ways.

1. *Mi sol ut mi*, which we call a chord of the *sixth*, composed of a third, a sixth, and an octave and in this case the note *mi* is marked with a 6. (See LVI.)

2. *Sol ut mi sol*, which we call a *chord of the sixth and fourth*, composed of a fourth, a sixth, and an octave; and it is marked with a $^{6}_{4}$. (See LVII.)

The perfect minor chord is inverted in the same manner.

The ways in which the CHORD *of the* SEVENTH *may be* INVERTED.

206. In the chord of the tonic dominant, as *sol si re fa*, the third major *si* above the fundamental note *sol* is called a *sensible note* (77.); and the inverted chord *si re fa sol*, composed of a third, a false fifth, and sixth, is called the *chord of the false fifth*, and is marked with an 8 or a ♭5 (see LVIII. and LIX.)

The chord *re fa sol si*, composed of a third, a fourth, and a sixth, is called the *chord of the sensible sixth*, and marked with a 6 or a ✱6. In this chord thus figured, the third is minor, and the sixth major, as it is easy to be perceived. (See LX.)

The chord *fa sol si re*, composed of a second, a tritone, and a sixth, is called the *chord of the tritone*, and is marked thus 4+, thus ×4, or thus ✱4. (See LXI.)

207. In the chord of the simple dominant *re fa la ut*, we find,

1. *Fa la ut re*, a chord of the great sixth, which is composed of a third, a fifth, and a sixth, and which is figured with a $^{6}_{5}$. See LXIII. (DDD).

2. *La ut re fa*, a chord of the lesser sixth, which is figured with a 6. See LXIV. (EEE).

3. *Ut re fa la*, a chord of the second, composed of a second, a fourth, and a sixth, and which is marked with a 2. See LXII. (FFF).

The ways in which the CHORD *of the sub-*DOMINANT *may be inverted.*

208. The chord of the sub-dominant, as *fa la ut re*, may be inverted in three different manners; but the method of inverting it which is most in practice is the chord of the lesser sixth *la ut re fa*, which is marked with a 6, and the chord of the seventh *re fa la ut*. See LXIV.

RULES *for the* CONTINUED BASS.

200. The continued bass is a fundamental bass, whose chords are only inverted in order to render it more in the taste of singing, and suitable to the voice. See LXV. in which the fundamental bass which in itself is monotonic and little suited for singing, *ut sol ut sol ut sol ut*, produces, by inverting its chords, this continued bass highly proper to be sung, *ut si ut re mi fa mi*, &c. (GGG.)

The continued bass then is properly nothing else but

(CCC) When the treble syncopates in descending diatonically, it is common enough to make the second part of the syncope carry a discord, and the first a concord. See *Example* LV. where the first part of the syncopated note *sol* is in concord with the notes *ut mi sol ut*, which answer to it in the fundamental bass, and where the second part is a dissonance in the subsequent chord *la ut mi sol*. In the same manner, the first part of the syncopated note *fa* is in concord with the notes *re fa la ut*, which answer to it; and the second part is a dissonance in the subsequent chord *sol si re fa*, which answer to it, &c.

(DDD) We are obliged to mark likewise, in the continued bass, the chord of the sub-dominant with a $^{6}_{5}$, which in the fundamental bass is figured with a 6 alone; and this to distinguish it from the chords of the sixth and of the lesser sixth. (See Examples LVI. and LXIV.) For what remains, the chord of the great sixth in the fundamental bass carries always the sixth major, whereas in the continued bass it may carry the sixth minor. For instance, the chord of the seventh *ut mi sol si*, gives the chord of the great sixth *mi sol si ut*, thus improperly called, since the sixth from *mi* to *ut* is minor.

(EEE) M. Rameau has justly observed, that we ought rather to figure this lesser sixth with a $^{6}_{4}$, to distinguish it from the sensible sixth which arises from the chord of the tonic dominant, and from the sixth which arises from the perfect chord. In the mean time he figures in his works with a 6 alone, the lesser sixths which do not arise from the tonic dominant; that is to say, he figures them as those which arise from the perfect chord; and we have followed him in that, though we thought with him, that it would be better to mark this chord by a particular figure.

(FFF) The chord of the seventh *si re fa la* gives, when inverted, the chord *fa la si re*, composed of a third, a tritone, and a sixth. This chord is commonly marked with a 6, as if the tritone were a just fourth. It is his business who performs the accompaniment, to know whether the fourth above *fa* be a tritone or a fourth redundant. One may, as to what remains, figure this chord thus $\begin{smallmatrix}6\\4+\\3\end{smallmatrix}$.

(GGG) The continued bass is proportionably better adapted to singing, as the sounds which form it more scrupulously observe the diatonic order, because this order is the most agreeable of all. We must therefore endeavour to preserve it as much as possible. It is for this reason that the continued bass in Example LXV. is much more in the taste of singing, and more agreeable, than the fundamental bass which answers to it.

Principles of Composition.

but a treble with respect to the fundamental bass. Its rules immediately follow; which are properly no other than those already given for the treble.

Rule I.

210. Every note which carries the chord of the false fifth, and which of consequence must be what we have called a *sensible note*, ought (77) to rise diatonically upon the note which follows it. Thus in example LXV. the note *si*, carrying the chord of the false fifth marked with an 8, rises diatonically upon *ut* (hhh).

Rule II.

211. Every note carrying the chord of the tritone should descend diatonically upon the subsequent note. Thus in the same example LXV. *fa*, which carries the chord of the triton figured with a 4+, descends diatonically upon *mi*. (Art. 202.)

Rule III.

212. The chord of the second is commonly put in practice upon notes which are syncopated in descending, because these notes are dissonances which ought to be prepared and resolved (200, 202.) See the example LXVI. where the second *ut*, which is syncopated, and which descends afterwards upon *si*, carries the chord of the second (iii).

Chap. IX. *Of some Licences assumed in the Fundamental Bass.*

§ 1. *Of* Broken *and* Interrupted Cadences.

211 Broken cadence how executed.

213. The broken cadence is executed by means of a dominant which rises diatonically upon another, or upon a tonic by a licence. See, in the example LXXIV. *sol la*, (132, and 134).

212 Interrupted cadence how formed.

214. The interrupted cadence is formed by a dominant which descends by a third upon another (136). See, in the example LXXV, *sol mi* (lll).

These cadences ought not to be permitted but rare- [g] ly

(hhh) The continued bass being a kind of treble with relation to the fundamental bass, it ought to observe the same rules with respect to that bass as the treble. Thus a note, for instance *re*, carrying a chord of the seventh *re fa la ut*, to which the chord of the sub-dominant *fa la ut re* corresponds in the fundamental bass, ought to rise diatonically upon *mi*, (art. 129, n° 2. and art. 202.)

(iii) When there is a *repose* in the treble, the note of the continued bass ought to be the same with that of the fundamental bass, (see example LXVII.) In the closes which are found in the treble at *si* and *ut* (bars third and fourth), the notes in the fundamental and continued bass are the same, viz. *sol* for the first cadence, and *ut* for the second. This rule ought above all to be observed in final cadences which terminate a piece or a modulation.

It is necessary, as much as possible, to prevent coincidences of the same notes in the treble and continued bass, unless the motion of the continued bass should be contrary to that of the treble. For example, in the second note of the second bar in example LXVII. *mi* is found at the same time in the continued bass and in the treble: but the treble descends from *fa* to *mi*, whilst the bass rises from *re* to *mi*.

Two octaves, or two fifths, in succession, must likewise be shunned. For instance, in the treble sounds *sol mi*, the bass must be prevented from sounding *sol mi*, *ut la*, or *re si*; because in the first case there are two octaves in succession, *sol* against *sol*, and *mi* against *mi*; and because in the second case there are two fifths in succession, *ut* against *sol*, and *la* against *mi*, or *re* against *sol*, and *si* against *mi*. This rule, as well as the preceding, is founded upon this principle, that the continued bass ought not to be a copy of the treble, but to form a different melody.

Every time that several notes of the continued bass answer to one note alone of the fundamental, the composer satisfies himself with figuring the first of them. Nay, he does not even figure it if it be a tonic; and he draws above the others a line, continued from the note upon which the chord is formed. See example LXVIII. where the fundamental bass *ut* gives the continued bass *ut mi sol mi*: the two *mi*'s ought in this bass to carry the chord 6, and *sol* the chord $\substack{6\\4}$: but as these chords are comprehended in the perfect chord *ut mi sol ut*, which is the first of the continued bass, we place nothing above *ut*, only we draw a line over *ut mi sol mi*.

In like manner, in the second bar of the same example, the notes *fa* and *re* of the continued bass, rising from the note *sol* alone of the fundamental bass which carries the chord *sol si re fa*; we think it sufficient to figure *fa* with the number of the tritone 4x, and to draw a line above *fa* and *re*.

It should be remarked, that this *fa* ought naturally to descend to *mi*: but this note is considered as subsisting so long as the chord subsists; and when the chord changes, we ought necessarily to find the *mi*, as may be seen by that example.

In general, whilst the same chord subsists in passing through different notes, the chord is reckoned the same as if the first note of the chord had subsisted; in such a manner, that, if the first note of the chord is, for instance, the sensible note, we ought to find the tonic when the chord changes. See example LXIX. or this continued bass, *ut si sol si re ut*, is reckoned the same with this *ut si ut*. (Example LXX.)

If a single note of the continued bass answers to several notes of the fundamental bass, it is figured with the different chords which agree to it. For example, the note *sol* in a continued bass may answer to this fundamental bass *ut sol ut*, (see example LXXI.); in this case, we may regard the note *sol* as divided into three parts, of which the first carries the chord $\substack{6\\4}$, the second the chord 7, and the third the chord $\substack{6\\4}$.

We shall repeat here, with respect to the rules of the continued bass, what we have formerly said concerning the rules of the fundamental bass in the note upon the third rule, art. 193. The rules of the continued bass have exceptions, which practice and the perusal of good authors will teach. There are likewise several other rules which might require a considerable detail, and which will be found in the *Treatise of Harmony* by M. Rameau, and elsewhere. These rules, which are proper for a complete dissertation, did not appear to me indispensably necessary in an *elementary essay upon music*, such as the present. The books which we have quoted at the end of our *preliminary discourse* will more particularly instruct the reader concerning this practical detail.

(lll) One may sometimes, but very rarely, cause several tonics in succession to follow one another in ascending

Principles of Compoſition.

ly and with precaution.

§ 2. *Of* Supposition.

213 Chord by ſuppoſition, what. See *Suppoſition*.

215. When a dominant is preceded by a tonic in the fundamental baſs, we add ſometimes, in the continued baſs to the chord of that dominant, a new note which is a third or a fifth below; and the chord which reſults from it in this continued baſs is called *a chord by ſuppoſition.*

For example, let us ſuppoſe that in the fundamental baſs we have a dominant *ſol* carrying the chord of the ſeventh *ſol ſi re fa*; let us add to this chord the note *ut*, which is a fifth below this dominant, and we ſhall have the total chord *ut ſol ſi re fa*, or *ut re fa ſol ſi*, which is called *a chord by ſuppoſition* (MM).

Of the different kinds of chords by ſuppoſition.

214 Theſe different chords what, and how figured.

216. It is eaſy to perceive, that chords by ſuppoſition are of different kinds. For inſtance, the chord of the tonic *ſol ſi re fa* gives,

1. By adding the fifth *ut*, the chord *ut ſol ſi re fa*, called a *chord of the ſeventh redundant*, and compoſed of a fifth, ſeventh, ninth, and eleventh. It is figured with a ※7; ſee LXXVI. (NNN). This chord is not practiſed but upon the tonic. They ſometimes leave out the ſenſible note, for reaſons which we ſhall give in the note QQQ, upon the art. 219; it is then reduced to *ut fa ſol re*, and marked with $\frac{5}{4}$ or $\frac{5}{2}$.

2. By adding the third *mi*, we ſhall have the chord *mi ſol ſi re fa*, called a *chord of the ninth*, and compoſed of a third, fifth, ſeventh, and ninth. It is figured with a 9. This third may be added to every third of the dominant. See LXXVII. (OOO).

3. If to a chord of the ſimple dominant, as *re fa la ut*, we ſhould add the fifth *ſol*, we would have the chord *ſol re fa la ut*, called a *chord of the eleventh*, and which is figured with a $\frac{9}{4}$ or $\frac{4}{9}$. (See LXXVIII.)

Observe.

215 Occaſions when retrenchments of chords are proper.

217. When the dominant is not a tonic dominant, they often take away ſome notes from the chord. For example, let us ſuppoſe that there is in the fundamental baſs this ſimple dominant *mi*, carrying the chord *mi ſol ſi re*: if there ſhould be added the third *ut* beneath, we ſhall have this chord of the continued baſs *ut mi ſol ſi re*, but they ſuppreſs the ſeventh *ſi*, for reaſons which ſhall be explained in the note QQQ upon art. 219. In this ſtate the chord is ſimply compoſed of a third, fifth, and ninth, and is marked with a 9. See LXXIX. (PPP).

218.

ing or deſcending diatonically, as *ut mi ſol ut*, *re fa la re*, *ſi♭ re fa ſi♭*; but, beſides that this ſucceſſion is harſh, it is neceſſary, in order to render it practicable, that the fifth below the firſt tonic ſhould be found in the chord of the tonic following, as here *fa*, a fifth below the firſt tonic *ut*, is found in the chord *re fa la re*, and in the chord *ſi♭ re fa ſi♭* (37 and note G.)

(MMM) Though ſuppoſition be a kind of licence, yet it is in ſome meaſure founded on the experiment related in the note (F), where you may ſee that every principal or fundamental ſound cauſes its twelfth and ſeventeenth major in deſcending to vibrate, whilſt the twelfth and the ſeventeenth major aſcending reſound: which ſeems to authorize us in certain caſes to join with the fundamental harmony this twelfth and ſeventeenth in deſcending, or which is the ſame thing, the fifth or the third beneath the fundamental ſound.

Even without having recourſe to this experiment, we may remark, that the note added beneath the fundamental ſound, cauſes that very fundamental ſound to be heard. For inſtance, *ut* added beneath *ſol*, cauſes *ſol* to reſound. Thus *ſol* is found in ſome meaſure to be implied in *ut*.

If the third added beneath the fundamental ſound be minor, for example, if to the chord *ſol ſi re fa*, we add the third *mi*, the ſuppoſition is then no longer founded on the experiment, which only gives the ſeventeenth major, or, what is the ſame thing, the third major beneath the fundamental ſound. In this caſe the addition of the third minor muſt be conſidered as an extenſion of the rule, which in reality has no foundation in the chords emitted by a ſonorous body, but is authorized by the ſanction of the ear and by practical experiment.

(NNN) Many muſicians figure this chord with a ※$^{7}_{2}$; M. Rameau ſuppreſſes this 2, and merely marks it to be the ſeventh redundant by a 7※ or ※7. But it may be ſaid, how ſhall we diſtinguiſh this chord from the ſeventh major, which, as it would ſeem, ought to be marked with a 7※? M. Rameau anſwers, that there is no danger of miſtake, becauſe in the ſeventh major, as the ſeventh ought to be prepared, it is found in the preceding chord; and thus the ſharp ſubſiſting already in the preceding chord, it would be uſeleſs to repeat it.

7
※

Thus *re ſol*, according to M. Rameau, would indicate *re fa※ la ut*, *ſol ſi re fa※*. If we would change *fa※*

7
※ 7♮

of the ſecond chord into *fa*, it would then be neceſſary to write *re ſol*. In notes ſuch as *ut*, whoſe natural ſeventh is major, the figure 7 preceded or followed by a ſharp will ſufficiently ſerve to diſtinguiſh the chord of the ſeventh redundant *ut ſol ſi re fa*, from the ſimple chord of the ſeventh *ut mi ſol ſi*, which is marked with a 7 alone. All this appears juſt and well-founded.

(OOO) Suppoſition introduces into a chord diſſonances which were not in it before. For inſtance, if to the chord *mi ſol ſi re*, we ſhould add the note of ſuppoſition *ut* deſcending by a third, it is plain that, beſides the diſſonance between *mi* and *re* which was in the original chord, we have two new diſſonances, *ut ſi* and *ut re*; that is to ſay, the ſeventh and the ninth. Theſe diſſonances, like the others, ought to be prepared and reſolved. They are prepared by being ſyncopated, and reſolved by deſcending diatonically upon one of the conſonances of the ſubſequent chord. The ſenſible note alone can be reſolved in aſcending; but it is even neceſſary that this ſenſible note ſhould be in the chord of the tonic dominant. As to the diſſonances which are found in the primitive chord, they ſhould always follow the common rules. (See art. 202.)

(PPP) Several muſicians call this laſt chord the *chord of the ninth*; and that which, with M. Rameau, we have

Principles of Composition.

218. What is more, in the chord of the simple dominant, as *re fa la ut*, when the fifth *sol* is added they frequently obliterate the sounds *fa* and *la*, that too great a number of dissonances may be avoided, which reduces the chord to *sol ut re*. This last is composed only of the fourth and the fifth. It is called a *chord of the fourth*, and it is figured with a 4. (See LXXX.)

219. Sometimes they only remove the note *la*, and

216 then the chord ought to be figured with $\frac{7}{4}$ or $\frac{4}{7}$ (QQQ).

Chord of the fifth redundant what, and how figured.

220. Finally, in the minor mode, for example, in that of *la*, where the chord of the tonic dominant (109), is *mi sol※ si re*; if we add to this chord the third *ut* below, we shall have *ut mi sol※ si re*, called the *chord of the fifth redundant*, and composed of a third, a fifth redundant, a seventh, and a ninth. It is figured with a ※5, or a +5. See LXXXI. (RRR).

217 § 3. *Of the* CHORD *of the* DIMINISHED SEVENTH.

Chord of the flat seventh what, and how figured.

221. In the minor mode, for instance, in that of *la*, *mi* a fifth from *la* is the tonic dominant (109), and carries the chord *mi sol※ si re*, in which *sol* is the sensible note. For this chord they sometimes substitute that other *sol※ si re fa* (116), all composed of minor thirds; and which has for its fundamental sound the sensible note *sol※*. This chord is called a *chord of the flat, or diminished seventh*, and is figured with a $\not 7$ in the fundamental bass, (see LXXXII.): but it is

218 always considered as representing the chord of the tonic dominant.

Chords produced in the continued bass by this what, and how figured.

222. This chord in the fundamental bass produces in the continued bass the following chords:

1. The chord *si re fa sol※*, composed of a third, false fifth, and sixth major. They call it the *chord of the sixth sensible and false fifth*; and it is figured thus $※^{6}_{8}$, or $+^{6}_{8}$. (See LXXXIII).

2. The chord *re fa sol※ si*, composed of a third, a triton, and a sixth, they call it the *chord of the triton and third minor*; and they mark it thus $※\overset{4}{\flat}$. (See LXXXIV).

3. The chord *fa sol※ si re*, composed of a second redundant, a tritone, and a sixth. They call it the *chord of the second redundant*, and they figure it thus ※2, or +2. See LXXXV. (SSS).

219 Alterations by supposition, chords which they produce what, and how figured.

223. Besides, since the chord *sol※ si re fa*, represents the chord *mi sol※ si re*, it follows, that if we operate by supposition upon the first of these chords, it must be performed as one would perform it upon *mi sol※ si re*; that is to say, that it will be necessary to add to the chord *sol※ si re fa*, the notes *ut* or *la*, which are the third or fifth below *mi*, and which will produce,

1. By adding *ut*, the chord *ut sol※ si re fa*, composed of a fifth redundant, a seventh, a ninth, and eleventh, which is the octave of the fourth. It is called a *chord of the fifth redundant and fourth*, and thus marked $+^{5}_{4}$, or $※^{5}_{4}$. (See LXXXVI.)

2. By adding *la*, we shall have the chord *la sol※ si re fa*, composed of a seventh redundant, a ninth, an eleventh, and a thirteenth minor, which is the octave of the sixth minor. It is called the *chord of the seventh redundant and sixth minor*, and marked $\overset{+7}{\flat 6}$, or $\overset{※7}{\flat}$. (See LXXXVII.) It is of all chords the most harsh, and the most rarely practised (TTT).

[g 2] In

have simply called a *chord of the ninth*, they term a *chord of the ninth and seventh*. This last chord they mark with a $^{9}_{7}$; but the denomination and figure used by M. Rameau are more simple, and can lead to no error; because the chord of the ninth always includes the seventh, except in the cases of which we have already spoken.

(QQQ) They often remove some dissonances from chords of supposition, either to soften the harshness of the chord, or to remove discords which can neither be prepared nor resolved. For instance, let us suppose, that in the continued bass the note *ut* is preceded by the sensible note *si*, carrying the chord of the false fifth, and that we should choose to form upon this note *ut* the chord *ut mi sol si re*, we must obliterate the seventh *si*, because in retaining it we should destroy the effect of the sensible note $\overset{8}{si}$, which ought to rise to *ut*.

In the same manner, if to the harmony of a tonic dominant *sol si re fa*, one should add the note by supposition *ut*, it is usual to retrench from this chord the sensible note *si*; because, as the *re* ought to descend diatonically to *ut*, and the *si* to rise to it, the effect of the one would destroy that of the other. This above all takes place in the *suspense*, concerning which we shall presently treat.

(RRR) *Supposition* produces what we call *suspense*; and which is almost the same thing. Suspension consists in retaining as many as possible of the sounds in a preceding chord, that they may be heard in the chord which succeeds. For instance, if this fundamental bass be given *ut* $\overset{7}{sol}$ *ut*, and this continued bass above it *ut ut* $\overset{※7}{ut}$, it is a supposition; but if we have this fundamental bass *ut* $\overset{7}{sol}$ $\overset{7}{sol}$ *ut*, and this continued bass above it *ut* $\overset{7}{sol}$ *ut* $\overset{※7}{ut}$, it is a suspense; because the perfect chord of *ut*, which we naturally expect after *sol* in the continued bass, is *suspended* and *retarded* by the chord $\overset{※7}{ut}$, which is formed by retaining the sounds *sol si re fa* of the preceding chord to join them to the note *ut* in this manner, *ut sol si re fa;* but this chord $\overset{※7}{ut}$ does nothing in this case but *suspend* for a moment the perfect chord *ut mi sol ut*, which ought to follow it.

(SSS) The chord of the diminished seventh, such as *sol※ si re fa*, and the three derived from it, are termed *chords of substitution*. They are in general *harsh*, and proper for imitating melancholy objects.

(TTT) As the chord of the diminished seventh *sol※ si re fa*, and the chord of the tonic dominant *mi sol※ si, re*, only differ one from the other by the notes *mi* and *fa;* one may form a diatonic modulation of these two notes, and then the fundamental bass does nothing but pass from the tonic dominant to the sensible note, and from that note to the tonic dominant, till it arrives at the tonic. (See XCII.)

For the same reason, as the chord of the diminished seventh *sol※ si re fa*, and the chord *si re fa la*, which carries

Principles of Composition.

In the *Treatise of Harmony* by M. Rameau, and elsewhere, may be seen a much longer detail of the chords by supposition: But here we delineate the elements alone.

Chap. X. *Of some Licences used in the Treble and Continued Bass.*

220 Licence 1st.

224. Sometimes in a treble, the dissonance which ought to have been resolved by descending diatonically upon the succeeding note, instead of descending, on the contrary rises diatonically: but in that case, the note upon which it ought to have descended must be found in some of the other parts. This licence ought to be rarely practised.

In like manner, in a continued bass, the dissonance in a chord of the sub-dominant inverted, as *la* in the chord *la ut mi sol*, inverted from *ut mi sol la*, may sometimes descend diatonically instead of rising as it ought to do, art. 129. n° 2.; but in that case the note ought to be repeated in another part, that the dissonance may be there resolved in ascending.

221 Licence 2d.

225. Sometimes likewise, to render a continued bass more agreeable by causing it to proceed diatonically, they place between two sounds of that bass a note which belongs to the chord of neither. See example XCIV, in which the fundamental bass *sol ut* produces the continued bass *sol la si sol ut*, where *la* is added on account of the diatonic modulation. This *la* has a line drawn above it to shew its resolution by passing under the chord *sol si re fa*.

In the same manner, (see XCV), this fundamental bass *ut fa* may produce the continued bass *ut re mi ut fa*, where the note *re* which is added passes under the chord *ut mi sol ut*.

Chap. XI. *Containing the Method of finding the Fundamental Bass when the Continued Bass is figured.*

222 How to find the fundamental bass when the continued is figured.

226. To exercise yourself with greater ease in finding the fundamental bass, and to render it more familiar to you, it is necessary to observe how eminent masters, and above all how M. Rameau, has put the rules in practice. Now, as they never place any thing but the continued bass in their works, it becomes then necessary to know how to find the fundamental bass when the continued bass is figured. This problem may be easily solved by the following rules.

227. 1. Every note which has no figure in the continued bass, ought to be the same, and without a figure in the fundamental bass; it either is a tonic, or reckoned such, (uuu).

2. Every note which in the continued bass carries a 6, ought in the fundamental bass to give its third below not figured *, or its fifth below marked with a 7. We shall distinguish these two cases below. (See LVI and LXIV, and the note zzz.)

* See *Figured*.

3. Every note carrying $\frac{6}{4}$ gives in the fundamental bass its fifth below not figured. (See LVII.)

4. Every note figured with a 7 or a ♯, is the same in both basses, and with the same figure (xxx).

5. Every note figured with a 2 gives in the fundamental bass the diatonic note above figured with a 7. See LXII. (yyy).

6. Every note marked with a 4 gives in the fundamental bass the diatonic note above, figured with a 7. (See LXI.)

7. Every

carries the fifth *si* of the tonic dominant *mi*, only differs by the sensible note *sol*※, and the tonic *la*; one may sometimes, while the treble modulates *sol*※ *la sol*※ *la sol*※ *la*, ascend in the fundamental bass, from the sensible note to the third above, provided one descend at last from thence to the tonic dominant, and from thence to the tonic; (see XCIII.) As to what remains, this and the preceding examples are licences.

(uuu) I say a tonic, or *reckoned such*, because it may perhaps be a dominant from which the dissonance has been removed. But in that case one may know that it is a real dominant by the note which precedes it. For instance, if the note *sol*, carrying a perfect chord, is preceded by *re* a simple dominant, carrying the chord *re fa la ut*, that note *sol* is not a real tonic; because, in order to this, it would have been necessary that *re* should have been a tonic dominant, and should have carried the chord *re fa*※ *la ut*; and that a simple dominant, as *re*, carrying the chord *re fa la ut*, should only naturally descend to a dominant, (art. 194.)

(xxx) Sometimes a note which carries a 7 in the continued bass, gives in the fundamental bass its third above, figured with a 6. For example, this continued bass $\overset{7}{la}$ $\overset{8}{si}$ *ut* gives this fundamental bass $\overset{6}{ut}$ $\overset{7}{sol}$ *ut*; but in this case it is necessary that the note figured with a 6 should rise by a fifth, as we see here *ut* rise to *sol*.

(yyy) A note figured with a 2, gives likewise sometimes in the fundamental bass its fourth above, figured with a 6; but it is necessary in that case that the note figured with a 6, may even here rise to a fifth. (See note xxx).

These variations in the fundamental bass, as well in the chord concerning which we now treat, as in the chord figured with a 7, and in two others which shall afterwards be mentioned (art. 228 and 229), are caused by a deficiency in the signs proper for the chord of the sub-dominant, and for the different arrangements by which it is inverted.

M. l'Abbe Roussier, to redress this deficiency, had invented a new manner of figuring the continued bass. His method is most simple for those who know the fundamental bass. It consists in expressing each chord by only signifying the fundamental sound with that letter of the scale by which it is denominated, to which is joined a 7 or ♯, or a 6, in order to mark all the discords. Thus the fundamental chord of the seventh *re fa la ut* is expressed by a $\overset{7}{D}$; and the same chord, when it is inverted from that of the sub-dominat *fa la ut re*, is characterized by $\overset{6}{F}$; the chord of the second *ut re fa la*, inverted from the dominant *re fa la ut*, is likewise represented by $\overset{7}{D}$; and the same chord *ut re fa la* inverted from that of the sub-dominant *fa la ut re* is signified by $\overset{6}{F}$: the case is the same when the chords are differently inverted. By this means it would be impossible to mistake either with respect to the fundamental bass of a chord, or with respect to the note which forms its dissonance, or with respect to the nature and species of that discord.

Principles of Composition.

7. Every note figured with an 8 gives its third below figured with a 7. (See LVIII.)

8. Every note marked with a $\not{6}$ gives the fifth below marked with a 7; (see LX.) and it is plain by art. 187, that in the chord of the seventh, of which we treat in these three last articles, the third ought to be major, and the seventh minor, this chord of the seventh being the chord of the tonic dominant. (See art. 102.)

9. Every note marked with a 9 gives its third above figured with a 7. (See LXXVII and LXXIX.)

10. Every note marked with a $\frac{9}{4}$ gives the fifth above figured with a 7. (See LXXVIII.)

11. Every note marked with a ※5, or with a +5, gives the third above figured with a $\overset{7}{\text{※}}$. (See LXXXI.)

12. Every note marked with a ※7 gives a fifth above figured with a 7, or with a $\overset{7}{\text{※}}$. (See LXXVI.) It is the same case with the notes marked $\frac{7}{4}$, $\overset{5}{\underset{2}{4}}$, or $\frac{5}{2}$: which shews a retrenchment, either in the complete chord of the eleventh, or in that of the seventh redundant.

13. Every note marked with a 4 gives a fifth above figured with a 7, or a $\overset{7}{\text{※}}$. (See LXXX.)

14. Every note marked with a ※$\frac{6}{8}$ gives the third minor below, figured with a #. (See LXXXIII.)

15. Every note marked with a ※$\overset{4}{\flat}$ gives the tritone above, figured with a #. (See LXXXIV.)

16. Every note marked with a +2 gives the second redundant above, figured with a #. (See LXXXV.)

17. Every note marked with a ※$\frac{5}{4}$ gives the fifth redundant above, figured with a #. (See LXXXVI.)

18. Every note marked with a $\begin{matrix}\text{※}7\\ \flat 6\end{matrix}$ gives the seventh redundant above, figured with a #. See LXXXVII. (zzz).

REMARK.

223 A difficulty in finding the fundamental bass.

228. We have omitted two cases cases, which may cause some uncertainty.

The first is that where the note of the continued bass is figured with a 6. We now present the reason of the difficulty.

Suppose we should have the dominant $\overset{7}{re}$ in the fundamental bass, the note which answers to it in the continued bass may be *la* carrying the figure 6, (see LXIV.); that is to say, the chord *la ut re fa*: now if we should have the sub-dominant $\overset{6}{fa}$ in the fundamental bass, this sub-dominant might produce in the continued bass the same note *la* figured with a 6. When therefore one finds in the continued bass a note marked with a 6, it appears at first uncertain whether we should place in the fundamental bass the fifth below marked with a 7, or the third below marked with a 6.

224 Another.

229. The second case is that in which the continued bass is figured with a $\frac{6}{5}$. For instance, if there should be found $\overset{6}{\underset{}{\overset{5}{fa}}}$ in the continued bass, one may be ignorant whether he ought to insert in the fundamental bass *fa* marked with a 6, or *re* figured with a 7.

225 Solution.

230. You may easily extricate yourself from this little difficulty, in leaving for an instant this uncertain note in suspense, and in examining what is the succeeding note of the fundamental bass; for if that note be in the present case a fifth above *fa*, that is to say, if it is *ut*, in this case, and in this alone, he may place $\overset{6}{fa}$ in the fundamental bass. It is a consequence of this rule, that in the fundamental bass every sub-dominant ought to rise by a fifth (195).

CHAP. XII. *What is meant by being in a Mode or Tone.*

226 Method of determining the mode in which we are.

231. IN the first part of this treatise (chap. vi.), we have explained, how by the means of the note *ut*, and of its two fifths *sol* and *fa*, one in ascending, which is called a *tonic dominant*, the other in descending, which is called a *sub-dominant*, the scale *ut re mi fa sol la si ut* may be found; the different sounds which form this scale compose what we call the *major mode* of *ut*, because the third *mi* above *ut* is major. If therefore we would have a modulation in the major mode of *ut*, no other sounds must enter into it than those which compose this scale; in such a manner that if, for instance, I should find *fa*※ in this modulation, this *fa*※ discovers to me that I am not in the mode of *ut*, or at least that, if I have been in it, I am no longer so.

232. In the same manner, if I form this scale in ascending *la si ut*※ *re mi fa*※ *sol*※ *la*, which is exactly similar to the scale *ut re mi fa sol la si ut* of the major mode of *ut*, this scale, in which the third from *la* to *ut*※ is major, shall be in the major mode of *la*; and if I incline to be in the minor mode of *la*, I have nothing to

(zzz) We may only add, that here and in the preceding articles, we suppose, that the continued bass is figured in the manner of M. Rameau. For it is proper to observe, that there are not, perhaps, two musicians who characterize their chords with the same figures; which produces a great inconveniency to the person who plays the accompaniments, as may be seen in the article *Chiffrer*, in Vol. III. of the *Encyclopedie*; an admirable article, of which M. Rousseau of Geneva is the author: but here we do not treat of accompaniments. For every reason, then, we should advise initiates to prefer the continued basses of M. Rameau to all the others, as by them they will most successfully study the fundamental bass.

It is even necessary to advertise the reader, and I have already done it (note EEE), that M. Rameau only marks the lesser sixth by a 6 without a line, when this lesser sixth does not result from the chord of the tonic dominant; in such a manner that the 6 renders it uncertain whether in the fundamental bass we ought to choose the third or the fifth below: but it will be easy to see whether the third or the fifth is signified by that figure. This may be distinguished, 1. In observing which of the two notes is excluded by the rules of the fundamental bass. 2. If the two notes may with equal propriety be placed in the fundamental bass, the preference must be determined by the tone or mode of the treble in that particular passage. In the following chapter we shall give rules for determining the mode.

There is a chord of which we have not spoken in this enumeration, and which is called the *chord of the sixth redundant*. This chord is composed of a note, of its third major, of its redundant fourth or tritone, and its redundant sixth, as *fa la si re*※. It is marked with a 6※. It appears difficult to find a fundamental bass for this chord; nor is it indeed much in use amongst us. (See the note upon the art. 115.)

to do but to ſubſtitute for *ut* ſharp *ut* natural; ſo that the major third *la ut*※ may become minor *la ut;* I ſhall have then

la ſi ut re mi fa※ *ſol*※ *la,*

which is (85) the ſcale of the minor mode of *la* in aſcending; and the ſcale of the minor mode of *la* in deſcending ſhall be (90)

la ſol fa mi ut re ſi la,

in which the *ſol* and *fa* are no longer ſharp. For it is a ſingularity peculiar to the minor mode, that its ſcale is not the ſame in riſing as in deſcending (89).

227 Hence it appears what ſharps and flats ſhould be placed at the cleff in the major mode of *la*, and why they are omitted in the minor mode in deſcending.

233. This is the reaſon why, when we wiſh to begin a piece in the major mode of *la*, we place three ſharps at the cleff upon *fa*, *ut*, and *ſol;* and on the contrary, in the minor mode of *la*, we place none, becauſe the minor mode of *la*, in deſcending, has neither ſharps nor flats.

228 Modes 24 in the whole.

234. As the ſcale contains twelve ſounds, each diſtant from the other by the interval of a ſemitone, it is obvious that each of theſe ſounds can produce both a major and a minor mode, which conſtitute 24 modes upon the whole. Of theſe we ſhall immediately give a table, which may be very uſeful to diſcover the mode in which we are.

A TABLE of the DIFFERENT MODES.

Major Modes.

Maj. Mode.	
of *ut*	*ut re mi fa ſol la ſi ut.*
of *ſol*	*ſol la ſi ut re mi fa*※ *ſol.*
of *re*	*re mi fa*※ *ſol la ſi ut*※ *re.*
of *la*	*la ſi ut*※ *re mi fa*※ *ſol*※ *la.*
of *mi*	*mi fa*※ *ſol*※ *la ſi ut*※ *re*※ *mi.*
of *ſi*	*ſi ut*※ *re*※ *mi fa*※ *ſol*※ *la*※ *ſi.*
of *fa*※	*fa*※ *ſol*※ *ſi ut*※ *re*※ *mi*※ *fa*※ (AAAA).
of *ut*※ or *re*♭	*re*♭ *mi*♭ *fa ſol*♭ *la*♭ *ſi*♭ *ut re*♭.
of *ſol*※ or *la*♭	*la*♭ *ſi*♭ *ut re*♭ *mi*♭ *fa ſol la*♭.
of *re*※ or *mi*♭	*mi*♭ *fa ſol la*♭ *ſi*♭ *ut re mi*♭.
of *la*※ or *ſi*♭	*ſi*♭ *ut re mi*♭ *fa ſol la ſi.*
of *mi*※ or *fa*	*fa ſol la ſi*♭ *ut re mi fa.*
of *ſi*※ or *ut*♭	*ut re mi fa ſol la ſi ut.*

Minor Modes.

Of *la*.

In deſcending. *la ſol fa mi re ut ſi la.*
In riſing. *la ſi ut re mi fa*※ *ſol*※ *la.*

Of *mi*.

In deſcending. *mi re ut ſi la ſol fa*※ *mi.*
In riſing. *mi fa*※ *ſol la ſi ut*※ *re*※ *mi.*

Of *ſi*.

In deſcending. *ſi la ſol fa*※ *mi re ut*※ *ſi.*
In riſing. *ſi ut*※ *re mi fa*※ *ſol*※ *la*※ *ſi.*

Of *fa*※.

In deſcending. *fa*※ *mi re ut*※ *ſi la ſol*※ *fa.*
In riſing. *fa*※ *ſol*※ *la ſi ut*※ *re*※ *mi*※ *fa*※.

Of *ut*※.

In deſcending. *ut*※ *ſi la ſol*※ *fa*※ *mi re*※ *ut*※.
In riſing. *ut*※ *re*※ *mi fa*※ *ſol*※ *la*※ *ſi*※ *ut*※.

Of *ſol*※ or *la*♭.

In deſcending. *ſol*※ *fa*※ *mi ut*※ *ſi la*※ *ſol*※.
In riſing. *la*♭ *ſi*♭ *ut*♭ *re*♭ *mi*♭ *fa ſol la*♭.

Of *re*※ or *mi*♭.

In deſcending. *mi*♭ *re*♭ *ut*♭ *ſi*♭ *la*♭ *ſol*♭ *fa mi*♭.
In riſing. *mi*♭ *fa ſol*♭ *la*♭ *ſi*♭ *ut re mi*♭.

Of *la*※ or *ſi*♭.

In deſcending. *ſi*♭ *la*♭ *ſol*♭ *fa mi*♭ *re*♭ *ut ſi*♭.
In riſing. *ſi*♭ *ut re*♭ *mi*♭ *fa ſol la ſi*♭.

Of *mi*※ or *fa*♭.

In deſcending. *fa mi*♭ *re*♭ *ut ſi*♭ *la*♭ *ſol fa.*
In riſing. *fa ſol la*♭ *ſi*♭ *ut re mi fa.*

Of *ut*.

In deſcending. *ut ſi*♭ *la*♭ *ſol fa mi*♭ *re ut.*
In riſing. *ut re mi*♭ *fa ſol la ſi ut.*

Of *ſol*.

In deſcending. *ſol fa mi*♭ *re ut ſi*♭ *la ſol.*
In riſing. *ſol la ſi*♭ *ut re mi fa*※ *ſol.*

Of *re*.

In deſcending. *re ut ſi*♭ *la ſol fa mi re.*
In riſing. *re mi fa ſol la ſi ut*※ *re* (BBBB).

235.

(AAAA) The major mode of *fa*※, of *ut*♭ or *re*※, and of *ſol*※ or *la*♭, are not much practiſed. In the opera of *Pyramus* and *Thiſbe*, p. 267, there is a paſſage in the ſcene, of which one part is in the major mode of *fa*※, and the other in the major mode of *ut*※, and there are ſix ſharps at the cleff.

When a piece begins upon *ut*※, there ought to be ſeven ſharps placed at the cleff: but it is more convenient only to place five flats, and to ſuppoſe the key *re*♭, which is almoſt the ſame thing with *ut*※. It is for this reaſon that we ſubſtitute here the mode of *re*♭ for that of *ut*※.

It is ſtill much more neceſſary to ſubſtitute the mode of *la*♭ for that of *ſol*※*;* for the ſcale of the major mode of *ſol* is *ſol*※, *la*※, *ſi*※, *ut*※, *re*※, *mi*※, *ſol*, *ſol*※,
in which you may ſee that there are at the ſame time both a *ſol* natural and a *ſol*※*:* it would then be neceeſary, even at the ſame time, that upon *ſol* there ſhould and ſhould not be a ſharp at the cleff; which is ſhocking and inconſiſtent. It is true that this inconvenience may be avoided by placing a ſharp upon *ſol* at the cleff, and by marking the note *ſol* with a natural through the courſe of the muſic wherever it ought to be natural; but this would become troubleſome, above all if there ſhould be occaſion to tranſpoſe. In the article 236, we ſhall give an account of tranſpoſition. One might likewiſe in this ſeries, inſtead of *ſol* natural, which is the note immediately before the laſt, ſubſtitute *fa*※※, that is to ſay, *fa* twice ſharp; which, however, is not abſolutely the ſame ſound with *ſol* natural, eſpecially upon inſtruments whoſe ſcales are fixed, or whoſe intervals are invariable. But in that caſe two ſharps may be placed at the cleff upon *fa*, which would produce another inconvenience. But by ſubſtituting *la*♭ for *ſol*※, the trouble is eluded.

(BBBB) We have already ſeen, that in each mode the *principal note* is called a *tonic;* that the fifth above that note

Principles of Composition.

235. These then are all the modes, as well major as minor. Those which are crowded with sharps and flats are little practised, as being extremely difficult in execution.

229 Modes crowded with sharps and flats little practised.

236. From thence it follows,

1. That when there are neither sharps nor flats at the cleff, it is a token that the piece begins in the major mode of *ut*, or in the minor mode of *la*.

230 Results.

2. That when there is one single sharp, it will always be placed upon *fa*, and that the piece begins in the major mode of *sol*, or the minor of *mi*, in such a manner that it may be sung as if there were no sharp, by singing *si* instead of *fa*※, and in singing the tune as if it had been in another cleff. For instance, let there be a sharp upon *fa* in the cleff of *sol* upon the first line; one may then sing the tune as if there were no sharp: And, instead of the cleff of *sol* upon the first line, let there be the cleff of *ut*; for the *fa*※, when changed into *si*, will require that the cleff of *sol* should be changed to the cleff of *ut*, as may be easily seen. This is what we call *transposition* (‡).

See *Transposition.*

237. It is evident, that when *fa*※ is changed into *si*, *sol* must be changed into *ut*, and *mi* into *la*. Thus by transposition, the air has the same melody as if it were in the major mode of *ut*, or in the minor mode of *la*. The major mode then of *sol*, and the minor of *mi*, are by transposition reduced to those of *ut* major, and of *la* minor. It is the same case with all the other modes, as any one may easily be convinced (cccc).

231 All the modes reducible to the major of *ut* and the minor of *la*.

CHAP.

note is called a *tonic dominant*, or the *dominant of the mode*, or simply a *dominant;* that the fifth beneath the tonic, or, what is the same thing, the fourth above that tonic, is called a *sub-dominant;* and in short, that the note which forms a semitone beneath the tonic, and which is a third major from the dominant, is called a *sensible note.* The other notes have likewise in every mode particular names which it is advantageous to know. Thus a note which is a tone immediately above the tonic, as *re* in the mode of *ut*, and *si* in that of *la*, is termed a *subtonic;* the following note, which is a third major or minor from the tonic, according as the chord is major or minor, such as *mi* in the major mode of *ut*, and *ut* in the minor mode of *la*, is called a *mediant;* in short, the note which is a tone above the dominant, such as *la* in the mode of *ut*, and *fa*※ in that of *la*, is called a *sub-dominant*.

(‡) Though our author's account of this delicate operation in music will be found extremely just and compendious; though it proceeds upon simple principles, and comprehends every possible contingency; yet as the manner of thinking upon which it depends may be less familiar to English readers, if not profoundly skilled in music, it has been thought proper to give a more familiar, though less comprehensive, explanation of the manner in which *transposition* may be executed.

It will easily occur to every reader, that if each of the intervals through the whole diatonic series were equal in a mathematical sense, it would be absolutely indifferent upon what note any air were begun, if within the compass of the gammut; because the same equal intervals must always have the same effects. But since, besides the natural semitones, there is another distinction of diatonic intervals into *greater* and *lesser tones;* and since these vary their positions in the series of an octave, according as the note from whence you begin is placed, that note is consequently the best key for any tune whose natural series is most exactly correspondent with the intervals which that melody or harmony requires. But in instruments whose scales are fixed, notwithstanding the temperament and other expedients of the same kind, such a series is far from being easily found, and is indeed in common practice almost totally neglected. All that can frequently be done is, to take care that the ear may not be sensibly shocked. This, however, would be the case, if, in transposing any tune, the situation of the semitones, whether natural or artificial, were not exactly correspondent in the series to which your air must be transposed, with their positions in the scale from which you transpose it. Suppose, for instance, your air should begin upon *ut* or C, requiring the natural diatonic series through the whole gammut, in which the distance between *mi* and *fa*, or E and F, as also that between *si* and *ut*, or B and C, is only a semitone. Again, suppose it necessary for your voice, or the instrument on which you play, that the same air should be transposed to *sol* or G, a fifth above its former key; then because in the first series the intervals between the third and the fourth, seventh and eighth notes, are no more than semitones, the same intervals must take the same places in the octave to which you transpose. Now, from *sol* or G, the note with which you propose to begin, the three tones immediately succeeding are full; but the fourth, *ut* or C, is only a semitone; it may therefore be kept in its place. But from *fa* or F, the seventh note above, to *sol* or G the eighth, the interval is a full tone, which must consequently be redressed by raising your *fa* a semitone higher. Thus the situations of the semitonic intervals in both octaves will be correspondent; and thus, by conforming the positions of the semitones in the octave to which you transpose, with those in the octave in which the original key of the tune is contained, you will perform your operation with as much success as the nature of fixed scales can admit: But the order in which you must proceed, and the intervals required in every mode, are minutely and ingeniously delineated by our author.

(cccc) Two sharps, *fa*※ and *ut*※, indicate the major mode of *re*, or the minor of *si;* and then, by transposition, the *ut*※ is changed into *si*, and of consequence, *re* into *ut*, and *si* into *la*.

Three sharps, *fa*※ *ut*※ *sol*※, indicate the major mode of *la*, or the minor of *fa*※*;* and it is then *sol*※, which must be changed into *si*, and of consequence *la* into *ut*, and *fa*※ into *la*.

Four sharps, *fa*※ *ut*※ *sol*※ *re*※, indicate the major mode of *mi*, or the minor of *ut*※*;* then the *re*※ is changed into *si*, and of consequence *mi* into *ut*, and *ut*※ into *la*.

Five sharps, *fa*※ *ut*※ *sol*※ *re*※ *la*※, indicate the major mode of *si*, or the minor of *sol*※*; la* then is changed into *si*, and of consequence *si* into *ut*, and *sol*※ into *la*.

Six sharps, *fa*※ *ut*※ *sol*※ *re*※ *la*※ *mi*※, indicate the major mode of *fa*※*; mi*※ then is changed into *si*, and of consequence *fa*※ into *ut*.

Six flats, *si*♭ *mi*♭ *la*♭ *re*♭ *sol*♭ *ut*♭, indicate the minor mode of *mi*♭*; ut* is changed into *fa*, and of consequence *mi*♭ into *la*.

Five

Principles of Composition.

CHAP. XIII. *To find the Fundamental Bass of a given Modulation.*

233 Method of finding a fundamental bass to a given air not difficult, and why.

238. As we have reduced to a very small number the rules of the fundamental bass, and those which in the treble ought to be observed with relation to this bass, it should no longer be difficult to find the fundamental bass of a given modulation, nay, frequently to find several; for every fundamental bass will be legitimate, when it is formed according to the rules which we have given (chap. VI.); and that, besides this, the dissonances which the modulation may form with this bass will both be prepared, if it is necessary that they should be so, and always resolved (DDDD).

239. It

Five flats, *si*♭ *mi*♭ *la*♭ *re*♭ *sol*♭, indicate the major mode of *re*♭, or the minor mode of *si*♭; then the *si*♭ is changed into *fa*, and of consequence the *re*♭ into *ut*, and the *si*♭ into *la*.

Four flats, *si*♭ *mi*♭ *la*♭ *re*♭, indicate the major mode of *la*♭, or the minor mode of *fa*; *re*♭ then is changed into *fa*, and of consequence *la*♭ into *ut*, and *fa* into *la*.

Three flats, *si*♭ *mi*♭ *la*♭, indicate the major mode of *mi*♭, or the minor of *ut*; the *la*♭ then is changed into *fa*, and of consequence *mi*♭ into *ut*, and the *sol* into *la*.

Two flats, *si*♭ *mi*♭, indicate the major mode of *si*♭, or the minor of *sol*; *mi*♭ then is changed into *fa*, and of consequence *si*♭ into *ut*, and the *fa* into *la*.

One flat, *si*♭, indicates the major mode of *fa*, or the minor mode of *re*, and *si*♭ is changed into *fa*; of consequence the *fa* is changed into *ut*, and the *re* into *la*.

All the major modes then may be reduced to that of *ut*, and the modes minor to that of *la* minor.

It only remains to remark, that many musicians, and amongst others the ancient musicians of France, as Lulli, Campra, &c. place one flat less in the minor mode: so that in the minor mode of *re*, they place neither sharp nor flat at the cleff; in the minor mode of *sol*, one flat only; in the minor mode of *ut*, two flats, &c.

This practice in itself is sufficiently indifferent, and scarcely merits the trouble of a dispute. Yet the method which we have here described, according to M. Rameau, has the advantage of reducing all the modes to two; and besides it is founded upon this simple and very general rule, That in the major mode, we must place as many sharps or flats at the cleff, as are contained in the diatonic scale of that mode in ascending; and in the minor mode, as many as are contained in that same scale in descending.

However this be, I here present you with a rule for transposition, which appears to me more simple than the rule in common use.

For the Sharps.

Suppose *sol*, *re*, *la*, *mi*, *si*, *fa*, and change *sol* into *ut* if there is one sharp at the cleff, *re* into *ut* if there are two sharps, *la* into *ut* if there are three, &c.

For the Flats.

Suppose *fa*, *si*, *mi*, *la*, *re*, *sol*, and change *fa* into *ut* if there is only one flat at the cleff, *si* into *ut* if there are two flats, *mi* into *ut* if there are three, &c.

(DDDD) We often say, *that we are upon a particular key*, instead of saying *that we are in a particular mode*. The following expressions therefore are synonimous; *such a piece is in* ut *major*, or *in the mode of* ut *major*, or *in the key of* ut *major*.

We have seen that the diatonic scale or gammut of the Greeks was *la si ut re mi fa sol la*, (art. 49.) A method has likewise been invented of representing each of the sounds in this scale by a letter of the alphabet; *la* by A, *si* by B, *ut* by C, &c. It is from hence that these forms of speaking proceed: Such a piece is upon A, *with* mi, la, *and its third minor*; or, simply, it is upon A, *with* mi, la, *and its minor*; such another piece upon C, *with* sol, ut, *and its third major*; or, simply, upon C, *with* sol, ut, *and its major*; to signify that the one is in the mode of *la minor*, or that the other is in that of *ut major*; this last manner of speaking is more concise, and on this account it begins to become general.

They likewise call the cleff of *ut fa* F, the cleff of *re sol* G, &c. to denominate the cleff of *fa*, the cleff of *sol*, &c.

They say likewise to take the A *mi la*, to give the A *mi la*; that is to say, to take the unison of a certain note called *la* in the harpsichord, which *la* is the same that occupies the fifth line, or the highest line in the first cleff of *fa*. This *la* divides in the middle the two octaves which subsist (note RR) between the *sol* which occupies the first line in the cleff of *sol* upon that same line, and that *sol* which occupies the first line in the cleff of *fa* upon the fourth; and as it possesses (if we may speak so) the middle station between the sharpest and lowest sounds, it has been chosen to be the sound with relation to which all the voices and instruments ought to be tuned in a concert (§).

(§) Thus far our author; and though the note is no more than an illustration of the technical phraseology in his native language, we did not think it consistent with the fidelity of a translation to omit it. We have little reason to envy, and still less to follow, the French in their abbreviations of speech; the native energy of our tongue supersedes this necessity in a manner so effectual, that, in proportion as we endeavour to become succinct, our style, without the smallest sacrifice of perspicuity, becomes more agreeable to the genius of our language: whereas, in French, laconic diction is equally ambiguous and disagreeable. Of this we cannot give a more flagrant instance than the note upon which these observations are made, in its original. We must, however, follow the author's example, in reciting a few technical phrases upon the same subject, which occur in our language, and which, if we are not mistaken, will be found equally concise, at the same time that they are more natural and intelligible. When we mean to express the fundamental note of that series within the diatonic octave which any piece of music demands, we call that note the *key*. When we intend to signify its mode, whether major or minor, we denominate the harmony *sharp* or *flat*. When in a concert we mean to try how instruments are in tune by that note upon which, according to the genius of each particular instrument, they may best agree in unison, we desire the musicians who join us to sound A.

234
Difficulty of aſſigning general rules for aſcertaining the mode of a melody whoſe fundamental baſs is ſought.

239. It is of the greateſt utility in ſearching for the fundamental baſs, to know what is the tone or mode of the melody to which that baſs ſhould correſpond. But it is difficult in this matter to aſſign general rules, and ſuch as are abſolutely without exception, in which nothing may be left that appears indifferent or diſcretionary; becauſe ſometimes we ſeem to have the free choice of referring a particular melody either to one mode or another. For example, this melody *ſol ut* may belong to all the modes, as well major as minor, in which *ſol* and *ut* are found together; and each of theſe two ſounds may even be conſidered as belonging to a different mode.

234
Reaſons why one may proceed without the knowledge of the mode, and how he may be preſerved from deviating in compoſition.

240. For what remains, one may ſometimes, as it ſhould ſeem, operate without the knowledge of the mode, for two reaſons: 1. Becauſe, ſince the ſame ſounds belong to ſeveral different modes, the mode is ſometimes conſiderably undetermined; above all, in the middle of a piece, and during the time of one or two bars. 2. Without giving ourſelves much trouble about the mode, it is often ſufficient to preſerve us from deviating in compoſition, if we obſerve in the ſimpleſt manner the rules above preſcribed (Ch. VI.) for the procedure of the fundamental baſs.

235
Knowledge of the mode in beginning a piece indiſpenſable, and why.

241. In the mean time, it is above all things neceſſary to know in what mode we operate at the beginning of the piece, becauſe it is indiſpenſible that the fundamental baſs ſhould begin in the ſame mode, and that the treble and baſs ſhould likewiſe end in it; nay, that they ſhould even terminate in its fundamental note, which in the mode of *ut* is *ut*, and *la* in that of *la*, &c. Beſides, in thoſe paſſages of the modulation where there is a cadence, it is generally neceſſary that the mode of the fundamental baſs ſhould be the ſame with that of the part to which it correſponds.

236
Inveſtigation of the mode continued.

242. To know upon what mode or in what key a piece commences, our inquiry may be entirely reduced to diſtinguiſh the major mode of *ut* from the minor of *la*. For we have already ſeen (art. 236. and 237.), that all the modes may be reduced to theſe two, at leaſt in the beginning of a piece. We ſhall now therefore give a detail of the different means by which theſe two modes may be diſtinguiſhed.

237
Means by which the modes may be determined.

1. From the principal and characteriſtical ſounds of the mode, which are *ut mi ſol* in the one, and *la ut mi* in the other; ſo that if a piece ſhould, for inſtance, begin thus, *la ut mi la*, it may be almoſt conſtantly concluded, that the tone or mode is in *la* minor, although the notes *la ut mi* belong to the mode of *ut*.

2. From the ſenſible note, which is *ſi* in the one, and *ſol*♯ in the other; ſo that if *ſol*♯ appears in the firſt bars of a piece, one may be certain that he is in the mode of *la*.

3. From the adjuncts of the mode, that is to ſay, the modes of its two fifths, which for *ut* are *fa* and *ſol*, and *re* and *mi* for *la*. For example, if after having begun a melody by ſome of the notes which are common to the modes of *ut*, and of *la*, (as *mi re mi fa mi re ut ſi ut*), I ſhould afterwards find the mode of *ſol*, which I aſcertain by the *fa*♯, or that of *fa* which I aſcertain by the *ſi*♭ or *ut*♮, I may conclude that I have begun in the mode of *ut*: but if I find the mode of *re*, or that of *mi*, which I aſcertain by *ſi*♭, *ut*♯, or *re*♯, &c. I conclude from thence that I have begun in the mode of *la*.

4. A mode is not for ordinary deſerted, eſpecially in the beginning of a piece; but that we may paſs into one or other of theſe modes which are moſt relative to it, which are the mode of its fifth above, and that of its third below, if the original mode be major, or of its third above if it be minor. Thus, for inſtance, the modes which are moſt intimately relative to the major mode of *ut*, are the major mode of *ſol*, and that of *la* minor. From the mode of *ut* we commonly paſs either into the one or the other of theſe modes; ſo that we may ſometimes judge of the principal mode in which we are, by the relative mode which follows it, or which goes before it, when theſe relative modes are deciſively marked. For what remains, beſides theſe two relative modes, there are likewiſe two others into which the principal mode may paſs, but leſs frequently, viz. the mode of its fifth below, and that of its third above, as *fa* and *mi* for the mode of *ut* (EEEE).

5. The modes may ſtill be likewiſe diſtinguiſhed by the cadences of the melody. Theſe cadences ought to occur at the end of every two, or at moſt of every four bars, as in the fundamental baſs: now the note of the fundamental baſs which is moſt ſuitable to theſe cloſes*, is always eaſy to be found. For the ſounds which occur in the treble may be conſulted M. Rameau, p. 54. of his *Nouveau Syſteme de Muſique theorique et pratique* (FFFF).

* See *Cadence*.

(h) When

(EEEE) It is certain that the minor mode of *mi* has an extremely natural connection with the mode of *ut*, as has been proved (art. 92.) both by arguments and by examples. It has likewiſe appeared in the note upon the art. 93. that the minor mode of *re* may be joined to the major mode of *ut*; and thus in a particular ſenſe, this mode may be conſidered as relative to the mode of *ut*: but it is ſtill leſs ſo than the major modes of *ſol* and *fa*, or than thoſe of *la* and *mi* minor; becauſe we cannot immediately, and without licence, paſs in a fundamental baſs from the perfect minor chord of *ut* to the perfect minor chord of *re*; and if you paſs immediately from the major mode of *ut*, to the minor mode of *re* in a fundamental baſs, it is by paſſing, for inſtance, from the tonic *ut*, or from *ut mi ſol ut*, to the tonic dominant of *re*, carrying the chord *la ut*♯ *mi ſol*, in which there are two ſounds, *mi ſol*, which are found in the preceding chord; or otherwiſe from *ut mi ſol ut* to *ſol ſi*♭ *re mi*, a chord of the ſub-dominant in the minor mode of *re*; which chord has likewiſe two ſounds, *ſol* and *mi*, in common with that which went immediately before it.

(FFFF) All theſe different manners of diſtinguiſhing the modes ought, if we may ſpeak ſo, to give mutual light and aſſiſtance one to the other. But it often happens, that one of theſe ſigns alone is not ſufficient to determine the mode, and may even lead to error. For example, if a piece of muſic begins with theſe three notes, *mi ut ſol*, we muſt not with too much precipitation conclude from thence that we are in the major mode of *ut*, although theſe three ſounds, *mi ut ſol*, be the principal and characteriſtical ſounds in the major mode of *ut*; we may be in the minor mode of *mi*, eſpecially if the note *mi* ſhould be long. You may ſee an example in the fourth act of *Zoroaſter*, where the firſt air ſung by the prieſts of Arimanes begins thus with two times, *ſol mi*♭ *ſi*♭, each of theſe notes being a crotchet. This air is in the minor mode of *ſol*, and not in the major mode of *mi*♭, as one would at firſt be tempted to believe it. Now we may be ſenſible that it is in *ſol* minor, by the relative modes which follow, and by the notes where the cadences fall.

Principles of Compoſition.

238
Having aſcertained the mode, the fundamental baſs not difficult.

When a perſon is once able to aſcertain the mode, and can render himſelf ſure of it by the different means which we have pointed out, the fundamental baſs will coſt little pains. For in each mode there are three fundamental ſounds.

1. The tonic of the mode, or its principal ſound, which carries always the perfect chord major or minor, according as the mode itſelf is major or minor.

Major mode of UT. *ut mi ſol ut.*
Minor mode of LA. *la ut mi la.*

2. The tonic dominant, which is a fifth above the tonic, and which, whether in the major or minor mode, always carries a chord of the ſeventh, compoſed of a third major followed by two thirds minor.

Tonic dominant.
Major mode of UT. *ſol ſi re fa.*
Tonic dominant.
Minor mode of LA. *mi ſol*※ *ſi re.*

3. The ſub-dominant, which is a fifth below the tonic, and which carries a chord compoſed of a third, fifth, and ſixth major, the third being either greater or leſſer, according as the mode is major or minor.

Sub-dominant.
Major mode of UT. *fa la ut re.*
Minor mode of LA. *re fa la ſi.*

Theſe three ſounds, the tonic, the tonic dominant, and the ſub-dominant, contain in their chords all the notes which enter into the ſcale of the mode; ſo that when a melody is given, it may almoſt always be found which of theſe three ſounds ſhould be placed in the fundamental baſs, under any particular note of the upper part. Yet it ſometimes happens that not one of theſe notes can be uſed. For example, let it be ſuppoſed that we are in the mode of *ut*, and that we find in the melody theſe two notes *la ſi* in ſucceſſion; if we confine ourſelves to place in the fundamental baſs one of the three ſounds *ut ſol fa*, we ſhall find nothing for the ſounds *la* and *ſi* but this fundamental baſs $\overset{6}{fa}\ \overset{7}{ſol}$; now ſuch a ſucceſſion as $\overset{6}{fa}$ to $\overset{7}{ſol}$ is prohibited by the fifth rule for the fundamental baſs, according to which every ſub-dominant, as *fa*, ſhould riſe by a fifth; ſo that $\overset{6}{fa}$ can only be followed by *ut* in the fundamental baſs, and not by $\overset{7}{ſol}$.

To remedy this, the chord of the ſub-dominant *fa la ut re* muſt be inverted into a fundamental chord of the ſeventh in this manner, *re fa la ut;* which has been called the *double employment* (art. 105.) becauſe it is a ſecondary manner of employing the chord of the ſub-dominant. By theſe means we give to the modulation *la ſi*, this fundamental baſs $\overset{7}{re}\ \overset{7}{ſol}$; which procedure is agreeable to rules.

Here then are four chords, *ut mi ſol ut, ſol ſi re fa, fa la ut re, re fa la ut*, which may be employed in the major mode of *ut*. We ſhall find in like manner, for the minor mode of *la*, four chords,

la ut mi la, mi ſol※ *ſi re,*
re fa la ſi, ſi re fa la.

And in this mode we ſometimes change the laſt of theſe chords into *ſi re fa*※ *la*, ſubſtituting the *fa*※ for *fa*♮. For inſtance, if we have this melody in the minor mode of *la, mi fa*※ *ſol*※ *la*, we would cauſe the firſt note *mi* to carry the perfect chord *la ut mi la*, the ſecond note *fa*※ to carry the chord of the ſeventh *ſi re fa*※ *la*, the third note *ſol*※ the chord of the tonic dominant *mi ſol*※ *ſi re*, and in ſhort, the laſt the perfect chord *la ut mi la*.

On the contrary, if this melody is given always in the minor mode *la la ſol*※ *la*, the ſecond *la* being ſyncopated, it might have the ſame baſs as the modulation *mi fa*※ *ſol*※ *la;* with this difference alone, that *fa*♮ might be ſubſtituted for *fa*※ in the chord *ſi re fa*※ *la*, the better to mark out the minor mode.

Beſides theſe chords which we have juſt mentioned, and which may be regarded as the principal chords of the mode, there are ſtill a great many others; for example, the ſeries of dominants,

7 7 7 7 7 7 7 7 7 7
ut la re ſol ut fa ſi mi la re ſol ut,

which are terminated equally in the tonic *ut*, either entirely belong, or at leaſt may be reckoned as belonging (GGGG) to the mode of *ut;* becauſe none of theſe dominants are tonic dominants except *ſol*, which is the tonic dominant of the mode of *ut;* and beſides, becauſe the chord of each of theſe dominants forms no other ſounds than ſuch as belong to the ſcale of *ut*.

But if I were to form this fundamental baſs,

7 7 7 7♭
ut la re ſol ut,

conſidering the laſt *ut* as a tonic dominant in this manner, *ut mi ſol ſi*♭; the mode would then be changed at the ſecond *ut*, and we ſhould enter into the mode of *fa;* becauſe the chord *ut mi ſol ſi*♭ indicates the tonic dominant of the mode of *fa;* beſides, it is evident that the mode is changed, becauſe *ſi*♭ does not belong to the ſcale of *ut*.

In the ſame manner, were I to form this fundamental baſs

7 7 7 6
ut la re ſol ut,

conſidering the laſt *ut* as a tonic dominant, in this manner, *ut mi ſol la;* this laſt *ut* would indicate the mode of *ſol*, of which *ut* is the *ſub-dominant*.

In like manner, ſtill, if in the firſt ſeries of dominants, I cauſed the firſt *re* to carry the third major, in this manner, *re fa*※ *la ut;* this *re* having become a tonic dominant, would ſignify to me the major mode of *ſol;* and the $\overset{7}{ſol}$ which ſhould follow it, carrying the chord $\overset{7}{ſi}$ *re fa*, would relapſe into the mode of *ut*, from whence we had departed.

Finally, in the ſame manner, if in this ſeries of dominants, one ſhould cauſe *ſi* to carry *fa*※ in this manner, *ſi re fa*※ *la;* this *fa* would ſhew that we had departed from the mode *ut*, to enter into that of *ſol*.

From

(GGGG) I have ſaid, *that they may be reckoned as belonging to this mode*, for two reaſons: 1. Becauſe, properly ſpeaking, there are only three chords which eſſentially and primitively belong to the mode of *ut*, viz. *ut* carrying the perfect chord, *fa* carrying that of the ſub-dominant, and *ſol* that of the tonic dominant, to which we may join the chord of the ſeventh, *re fa la ut* (art. 105.); but we here regard *as extended* the ſeries of dominants in queſtion, as belonging to the mode of *ut*, becauſe it preſerves in the ear the impreſſion of that mode. 2. In a ſeries of dominants, there are a great many of them which likewiſe belong to other modes; for inſtance, the ſimple dominant *la* belongs naturally to the mode of *ſol*, the ſimple dominant *ſi* to that of *la*, &c. Thus it is only improperly, and by way of extenſion, as I have already ſaid, that we regard here theſe dominants as belonging to the mode of *ut*.

Principles of Composition.

239 rule for discovering the changes of mode.

From hence it is easy to form this rule for discovering the changes of mode in the fundamental bass.

1. When we find a tonic in the fundamental bass, we are in the mode of that tonic; and the mode is major or minor, according as the perfect chord is major or minor.

2. When we find a sub-dominant, we are in the mode of the fifth above that sub-dominant; and the mode is major or minor, according as the third in the chord of the sub dominant is major or minor.

3. When we find a tonic dominant, we are in the mode of the fifth below that tonic dominant. As the tonic dominant carries always the third major, one cannot be secure by the assistance of this dominant alone, whether the mode be major or minor: but it is only necessary for the composer to cast his eye upon the following note, which must be the tonic of the mode in which he is; by the third of this tonic he will discover whether the mode be major or minor.

243. Every change of the mode supposes a cadence; and when the mode changes in the fundamental bass, it is almost always either after the tonic of the mode in which we have been, or after the tonic dominant of that mode, considered then as a tonic by favour of a close which ought necessarily to be found in that place: Whence it happens that cadences in a melody for the most part presage a change of mode which ought to follow them.

244. All these rules, joined with the table of modes which we have given (art. 234.), will serve to discover in what mode we are in the middle of a piece, especially in the most essential passages, as cadences (HHHH).

I here subjoin the soliloquy of *Armida*, with the continued and fundamental basses. The changes of the mode will be easily distinguished in the fundamental bass, by the rules which we have just given at the end of the article 242. This soliloquy will serve for a lesson to beginners. M. Rameau quotes it in his *New System of Music*, as an example of modulation highly just and extremely simple. (See Plate VI. and the following. (IIII).

Chap. XIV. *Of the Chromatic and Enharmonic.*

240 Chromatic, what.

245. We call that melody *chromatic* which is composed of several notes in succession, whether rising or descending by semitones. (See LXXXVIII. and LXXXIX.)

241 To an air descending by chromatic intervals, fundamental bass, what.

246. When an air is chromatic in descending, the most natural and ordinary fundamental bass is a concatenated series of tonic dominants; all of which follow one another in descending by a fifth, or which is the same thing, in rising by a fourth. See LXXXVIII. (LLLL).

242 Ascending, what.

247. When the air is chromatic in ascending, one may form a fundamental bass by a series of tonics and of tonic dominants, which succeed one another alternately by the interval of a third in descending, and of a fourth in ascending, (see LXXXIX.) There are many other ways of forming a chromatic air, whether in rising or descending; but these details in an elementary essay are by no means necessary.

243 Enharmonic little practised.

248. With respect to the enharmonic, it is very rarely put in practice; and we have explained its formation in the first book, to which we refer our readers. We shall content ourselves with saying, that, in the beautiful soliloquy of the fourth act of *Dardanus*, at the words *lieux funestes*, &c. "fatal places, &c." we find an example of the enharmonic; an example of the diatonic enharmonic

(HHHH) Two modes are so much more intimately relative as they contain a greater number of sounds common to both; for example, the minor mode of *ut* and the major of *sol*, or the major mode of *ut* and the minor of *la*: on the contrary, two modes are less intimately relative as the number of sounds which they contain as common to both is smaller; for instance, the major mode of *ut* and the minor of *si*, &c.

When you find yourself led away by the current of the modulation, that is to say, by the manner in which the fundamental bass is constituted, into a mode remote from that in which the piece was begun, you must continue in it but for a short time, because the ear is always impatient to return to the former mode.

(IIII) It is extremely proper to remark, that we have given the fundamental, the continued bass, and in general the modulation of this soliloquy, merely as a lesson in composition extremely suitable to *beginners*; not that we recommend the soliloquy in itself as a model of expression. Upon this last object what we have said may be seen in what we have written concerning the liberties to be taken in music, Vol. IV. p. 435. of our Literary Miscellany. It is precisely because this soliloquy is a proper lesson for initiates, that it would be a bad one for the mature and ingenious artist. The novice should learn tenaciously to observe his rules; the man of art and genius ought to know on what occasions and in what manner they may be violated when this expedient becomes necessary.

(LLLL) We may likewise give to a chromatic melody in descending, a fundamental bass, into which may enter chords of the seventh and of the diminished seventh, which may succeed one another by the intervals of a false fifth and a fifth redundant: thus in the Example XC. where the continued bass descends chromatically, it may easily be seen that the fundamental bass carries successively the chords of the seventh and of the seventh diminished, and that in this bass there is a false fifth from *re* to *sol*※, and a fifth redundant from *sol* ※ to *ut*.

The reason of this licence is, as it appears to me, because the chord of the diminished seventh may be considered as representing (art. 221.) the chord of the tonic dominant; in such a manner that this fundamental bass

7 7̸ 7 7 7 ※ (7)
la re sol※ *ut fa*※ *si mi la*

(see Example XCI.) may be considered as representing (art. 116.) that which is written below,

7 ※(7) 7 7 7 ※(7)
la re mi ut fa※ *si mi la.*

Now this last fundamental bass is formed according to the common rules, unless that there is a broken cadence ※(7) from *re* to *mi*, and an interrupted cadence from *mi* to *ut*, which are licenses (art. 213 and 214.)

enharmonic in the trio of the *Fatal Siſters*, in *Hippolitus* and *Aricia*, at the words, *Ou cours-tu malheureux*, "Whither, unhappy, doſt thou run;" and that there are no examples of the chromatic enharmonic, at leaſt in our French operas. M. Rameau had imitated an earthquake by this ſpecies of muſic, in the ſecond act of the *Gallant Indians;* but he informs us, that in 1735 he could not cauſe it to be executed by the band. The trio of the *Fatal Siſters* in *Hippolitus* has never been ſung in the opera as it is compoſed. But M. Rameau aſſerts, (and we have heard it elſewhere by people of taſte, before whom the piece was performed), that the trial had ſucceeded when made by able hands that were not mercenary, and that its effect was aſtoniſhing.

CHAP. XV. *Of Deſign, Imitation, and Fugue.*

See *Deſign.*

244 Deſign, what.

249. IN muſic, the name of *deſign*, or *ſubject*, is generally given to a particular air or melody, which the compoſer intends ſhould prevail through the piece; whether it is intended to expreſs the meaning of words to which it may be ſet, or merely inſpired by the impulſe of taſte and fancy. In this laſt caſe, deſign is diſtinguiſhed into *imitation* and *fugue*.

See *Imitation.*

245 Imitation, what.

* See *Air, Canon, Fugue.*

250. *Imitation* conſiſts in cauſing to be repeated the melody of one, or of ſeveral bars in one ſingle part, or in the whole harmony, and in any of the various modes that may be choſen. When all the parts abſolutely repeat the ſame air * or melody, and beginning one after the other, this is called a *canon*. *Fugue* conſiſts in alternately repeating that air in the treble, and in the baſs, or even in all the parts, if there are more than two.

246 Principal rules for compoſing in ſeveral parts.

251. Imitation and fugue are ſometimes conducted by rules merely deducible from taſte, which may be ſeen in the 332d and following pages of M. Rameau's *Treatiſe on Harmony;* where will likewiſe be found a detail of the rules for compoſition in ſeveral parts. The chief rules for compoſition in ſeveral parts are, that the diſcords ſhould be found, as much as poſſible, prepared and reſolved in the ſame part; that a diſcord ſhould not be heard at the ſame time in ſeveral parts, becauſe its harſhneſs would diſguſt the ear; and that in no particular part there ſhould be found two octaves or two fifths in ſucceſſion (MMMM) with reſpect to the baſs. Muſicians, however, do not heſitate ſometimes to violate this precept, when taſte or occaſion require. In muſic, as in all the other fine arts, it is the buſineſs of the artiſt to aſſign and to obſerve rules; the province of men who are adorned with taſte and genius is to find the exceptions.

CHAP. XVI. *Definitions of the Different Airs.*

252. WE ſhall finiſh this treatiſe by giving in a few words the characteriſtic diſtinctions of the different airs to which names have been given, as *chacoon, minuet, rigadoon*, &c.

The *chacoon* is a long piece of muſic, containing three times in each bar, of which the movement is regular, and the bars ſenſibly diſtinguiſhed. It conſiſts of ſeveral couplets, which are varied as much as poſſible. Formerly the baſs of the chacoon was a *conſtrained baſs*, or regulated by a rhythmus terminating in 4 bars, and proceeding again by the ſame number; at preſent compoſers of this ſpecies no longer confine themſelves to that practice. The chacoon begins, for the moſt part, not with the perfect time, which is ſtruck by the hand or foot, but with the imperfect, which paſſes while the hand or foot is elevated.

The *villanelle* is a chacoon a little more lively, with its movement ſomewhat more briſk than the ordinary chacoon.

The *paſſacaille* only differs from a chacoon as it is more ſlow, more tender, and beginning for ordinary with a perfect time.

The *minuet* is an air in triple time, whoſe movement is regular, and neither extremely briſk nor ſlow, conſiſting of two parts or ſtrains, which are each of them repeated; and for which reaſon they are called by the French *repriſes:* each ſtrain of the minuet begins with a time which is ſtruck, and ought to conſiſt of 4, of 8, or of 12 bars; ſo that the cadences may be eaſily diſtinguiſhed, and recur at the end of each 4 bars.

The *ſarabando* is properly a ſlow minuet; and the *courant* a very ſlow ſarabando: this laſt is no longer in uſe. The *paſſepied* is properly a very briſk minuet, which does not begin like the common minuet, with a ſtroke of the foot or hand; but in which each ſtrain begins in the laſt of the three times of which the bar conſiſts.

The *loure* is an air whoſe movement is ſlow, whoſe time is marked with $\frac{6}{4}$, and where two of the times in which the bar conſiſts are beaten; it generally begins with that in which the foot is raiſed. For ordinary the note in the middle of each time is ſhortened, and the firſt note of the ſame time pointed.

The *jig* is properly nothing elſe but a loure very briſk, and whoſe movement is extremely quick.

The *forlana* is a moderate movement, and in a mediocrity between the loure and the jig.

The *rigadoon* has two times in a bar, is compoſed of two ſtrains, each to be repeated, and each conſiſting of 4, of 8, or of 12 bars: its movement is lively; each ſtrain begins, not with a ſtroke of the foot, but at the laſt note of the ſecond time.

The *bourée* is almoſt the ſame thing with the rigadoon.

The *gavotte* has two times in each bar, is compoſed of two ſtrains, each to be repeated, and each conſiſting of 4, of 8, or of 12 bars: the movement is ſometimes ſlow, ſometimes briſk; but never extremely quick, nor very ſlow.

The *tambourin* has two ſtrains, each to be repeated, and each conſiſting of 4, of 8, or of 12 bars, &c. Two of the times that make up each bar are beaten, and are very lively; and each ſtrain generally begins in the ſecond time.

The *muſette* conſiſts of two or three times in each bar; its movement is neither very quick nor very ſlow; and for its baſs it has often no more than a ſingle note, which may be continued through the whole piece.

(MMMM) Yet there may be two fifths in ſucceſſion, provided the parts move in contrary directions, or, in other words, if the progreſs of one part be aſcending, and the other deſcending; but in this caſe they are not properly two fifths, they are a fifth and a twelfth; for example, if one of the parts in deſcending ſhould ſound *fa re*, and the other *ut la* in riſing, *ut* is the fifth of *fa*, and *la* the twelfth of *re*.

Glass MUSIC. See HARMONICA.

MUSK, a very strong-scented substance found under the belly of an East India animal. See MOSCHUS.

According to Tavernier, the best and greatest quantities of musk come from the kingdom of Boutan, from whence it is carried for sale to Patna, the chief town of Bengal. After killing the animal, the peasants cut off the bag, which is about the size of an egg, and is situated nearer the organs of generation than the navel. They next take out the musk, which has then the appearance of clotted blood. When they want to adulterate it, they put a mash of the animal's blood and liver into the place of the musk they had extracted. In two or three years this mixture produces certain small animals which eat the good musk; so that, when opened, a great consumption is perceived. Others, after extracting a portion of the musk, put in small pieces of lead to augment the weight. The merchants who transport the musk to foreign countries are less averse to this trick than the former; because in this case none of the animals abovementioned are produced. But the deceit is still worse to discover, when, of the skin taken from the belly of a young animal, they make little bags, which they sew so dextrously with threads of the same skin, that they resemble genuine bags. Those they fill with what they take out of the genuine bags, and some fraudulent mixture, which it is extremely difficult for the merchants to detect. When the bags are sewed immediately on their being cut, without allowing any part of the odour to dissipate in the air, after they have abstracted as much of the musk as they think proper, if a person applies one of these bags to his nose, blood will be drawn by the mere force of the odour, which must necessarily be weakened or diluted in order to render it agreeable without injuring the brain. Our author brought one of the animals with him to Paris, the odour of which was so strong, that it was impossible for him to keep it in his chamber. It made every head in the house giddy; and he was obliged to put it in a barn, where the servants at last cut away the bag: the skin, notwithstanding, always retained a portion of the odour. The largest musk-bag seldom exceeds the size of a hen's egg, and cannot furnish above half an ounce of musk: three or four of them are sometimes necessary to afford a single ounce. In one of his voyages to Patna, Tavernier purchased 1663 bags, which weighed 1557 ounces and a half; and the musk, when taken out of the bags, weighed 452 ounces.

Musk affords the strongest of all known odours. A small bit of it perfumes a large quantity of matter. The odour of a small particle extends through a considerable space. It is likewise so fixed and permanent, that at the end of several years it seems to have lost no part of its activity. When it comes to us it is dry, with a kind of unctuosity, of a dark reddish-brown or rusty blackish colour, in small round grains, with very few hard black clots, and perfectly free from any sandy or other visible foreign matter. If chewed, and rubbed with a knife on paper, it looks smooth, bright, yellowish, and free from bitterness. Laid on a red-hot iron, it catches flame, and burns almost entirely away, leaving only an exceeding small quantity of light greyish ashes: if any earthy substances have been mixed with the musk, the quantity of the residuum will readily discover them.

Musk has a bitterish subacrid taste; a fragrant smell, agreeable at a distance, but when smelt near to, so strong as to be disagreeable unless weakened by the admixture of other substances. If a small quantity be infused in spirit of wine in the cold for a few days, it imparts a deep, but not red tincture: this, though it discovers no great smell of the musk, is nevertheless strongly impregnated with its virtues; a single drop of it communicates to a whole quart of wine a rich musky flavour. The degree of flavour which a tincture drawn from a known quantity of musk communicates to vinous liquors, is perhaps one of the best criteria for judging of the goodness of this commodity. Neuman informs us, that spirit of wine dissolves ten parts out of thirty of musk, and that water takes up twelve; that water elevates its smell in distillation, whilst pure spirit brings over nothing.

Musk is a medicine of great esteem in the eastern countries; among us, it has been for some time pretty much out of use, even as a perfume, on a supposition of its occasioning vapours, &c. in weak females and persons of a sedentary life. It appears, however, from late experience, to be, when properly managed, a remedy of good service even against those disorders which it has been supposed to produce. Dr Wall has communicated (in the Philosoph. Transactions, n° 474.) an account of some extraordinary effects of musk in convulsive and other diseases, which have too often baffled the force of medicine. The doctor observes, that the smell of perfumes is often of disservice, where the substance, taken inwardly and in considerable quantity, produces the happiest effects; that two persons, labouring under a subsultus tendinum, extreme anxiety, and want of sleep, from the bite of a mad dog, by taking two doses of musk, each of which was sixteen grains, were perfectly relieved from their complaints. He likewise observes, that convulsive hickups, attended with the worst symptoms, were removed by a dose or two of ten grains; and that in some cases, where this medicine could not, on account of strong convulsions be administered to the patient by the mouth, it proved of service when injected as a glyster. He likewise adds, that under the quantity of six grains, he never found much effect from it; but that, taken to ten grains and upwards, it never fails to produce a mild diaphoresis, without at all heating or giving any uneasiness: that, on the contrary, it eases pain, raises the spirits; and that, after the sweat breaks out, the patient usually falls into a refreshing sleep: that he never met with any hysterical person, how averse soever to perfumes, but could take it, in the form of a bolus, without inconvenience. To this paper is annexed an account of some farther extraordinary effects of musk, observed by another gentleman. Repeated experience has since confirmed its efficacy in these disorders. The author of the New Dispensatory says, he has frequently given it with remarkable success; and sometimes increased the dose as far as twenty grains every four hours, with two or three spoonfuls of the musk julep between. The julep is the only officinal preparation of it.

MUSK-*Animal*. See MOSCHUS.

Musk-*Rat*, in zoology. See Castor.

MUSKET, a fire arm born on the ſhoulder, and uſed in war. See Gun, *par. ult.*

MUSKETOON, a kind of ſhort thick muſket, whoſe bore is the 38th part of its length: it carries five ounces of iron, or ſeven and an half of lead, with an equal quantity of powder. This is the ſhorteſt kind of blunderbuſſes.

MUSLIN, a fine ſort of cotton-cloth, which bears a downy knot on its ſurface. There are ſeveral ſorts of muſlins brought from the Eaſt Indies, and more particularly from Bengal; ſuch as doreas, betelles, mulmuls, tanjeebs, &c.

MUSONIUS, (Caius Rufus) a Stoic philoſopher of the ſecond century, was baniſhed into the iſland of Gyare, under the reign of Nero, for criticiſing the manners of that prince; but was recalled by the emperor Veſpaſian. He was the friend of Apollonius Tyanæus, and the letters that paſſed between them are ſtill extant.

MUSQUETOE. See Culex, in the Appendix.

MUSSULMAN, or Musulman, a title by which the Mahometans diſtinguiſh themſelves; ſignifying, in the Turkiſh language, "true believer, or orthodox." See Mahometanism.

In Arabic, the word is written *Moſlem*, *Moſleman*, or *Moſolman*. The appellation was firſt given to the Saracens; as is obſerved by Leunclavius.—There are two kinds of Muſſulmans, very averſe to each other; the one called *Sonnites*, and the other *Shiites*.—The Sonnites follow the interpretation of the Alcoran given by Omar; the Shiites are the followers of Ali. The ſubjects of the king of Perſia are Shiites; and thoſe of the grand ſignior, Sonnites. See Sonna, and Alcoran.

Some authors will have it, that the word Muſſulman ſignifies *ſaved*, that is, predeſtinated; and that the Mahometans give themſelves the appellation, as believing they are all predeſtinated to ſalvation.—Martinius is more particular as to the origin of the name; which he derives from the Arabic מסלם, *muſalem*, "ſaved, ſnatched out of danger:" the Mahometans, he obſerves, eſtabliſhing their religion by fire and ſword, maſſacred all thoſe who would not embrace it, and granted life to all that did, calling them *Muſſulmans*, q. d. *erepti è periculo;* whence the word, in courſe of time, became the diſtinguiſhing title of all thoſe of that ſect, who have affixed to it the ſignification of *true believer*.

MUST, Mustum, ſweet wine newly preſſed from the grape; or the new liquor preſſed from the fruit before it has worked or fermented. See Wine.

MUSTELA, in zoology, a genus of quadrupeds of the order of feræ. There are ſix erect, ſharp, diſtinct teeth in the upper jaw, and an equal number in the under jaw, but blunter and cloſer together, and two of them are ſituated a little farther within the mouth; and the tongue is ſmooth. There are 11 ſpecies, *viz.*

1. The lutris, or ſea-otter, hath palmated feet, and the tail about one-fourth of the length of the body; the hair thick, long, and exceſſively black and gloſſy: beneath that is a ſoft down; the colour ſometimes varies to ſilvery. The biggeſt of theſe animals weigh 70 or 80 pounds. They inhabit, in vaſt abundance, the coaſts of Kamtſchatka, and the parts of America oppoſite to it, diſcovered by the Ruſſians: it is alſo met with in a moſt remote part of the continent of America, along the rivers of Braſil and Paraguay, and in the Oroonoko. It is a harmleſs animal; very affectionate to its young, inſomuch that it will pine to death at the loſs of them, and die on the very ſpot where they have been taken from it. Before the young can ſwim, they carry them in their paws, lying in the water on their backs: they run very ſwiftly; ſwim often on their back, their ſides, and even in a perpendicular poſture: are very ſportive; embrace, and kiſs each other: they inhabit the ſhallows, or ſuch places as abound with ſea-weeds; feed on lobſters, and other ſhell-fiſh, as well as ſepiæ and common fiſhes: they breed but once a-year, and have but one young one at a time, ſuckle it for a year, and bring it on ſhore. They are dull-ſighted, but quick-ſcented: are hunted for their ſkins; which are of great value, being ſold to the Chineſe for 70 or 80 rubles a-piece; each ſkin weighs 3½ lib. The young are reckoned very delicate meat, ſcarce to be diſtinguiſhed from a ſucking lamb. The cry of this creature is nearly ſimilar to a young dog; and it is ſometimes interrupted by another cry ſimilar to that of the ſaki or fox-tailed monkey. It may be nouriſhed with the flour of manioc diluted in water.

2. The lutra, or otter, has palmated feet, the tail one half the length of the body; the whole colour is a deep brown, except two ſmall ſpots on each ſide of the noſe, and another below the chin; the legs are ſhort and thick, and looſely joined to the body: the length from the noſe to the tail is 23 inches. The otter inhabits all parts of Europe, the north and north-eaſt of Aſia, even as far as Kamtſchatka; it abounds in North America, particularly in Canada, from whence the moſt valuable furs of this kind are brought. He is a voracious animal, but fonder of fiſh than of fleſh: he doth not willingly quit the margins of rivers or lakes, and often depopulates fiſh-ponds; but if fiſh happens to fail, he makes excurſions on land, and preys on lambs and poultry. It is obſervable, that the otter always ſwims againſt the ſtream to meet its prey; and two of them, it is ſaid, will hunt a ſalmon in concert. One ſtations itſelf above, and the other below the place where the fiſh lies, and continue chaſing it inceſſantly, till the creature, quite wearied out, becomes their prey. Sometimes the otter preys in the ſea, but not far from ſhore. It hath been obſerved, however, in the Orkneys to bring in cod, congers, &c. Properly ſpeaking, he is not an amphibious animal; for, like other terreſtrial creatures, he requires the aid of frequent reſpiration. When in purſuit of a fiſh, if he chances to be entangled in a net, he drowns; and we perceive that he has not had time to cut a ſufficient quantity of the meſhes to effectuate his eſcape. For want of fiſhes, crabs, frogs, or other animal-food, he gnaws the young twigs, and eats the bark of aquatic trees; he likewiſe eats the young herbage in the ſpring. The female comes in ſeaſon in winter, brings forth in March, and the litter conſiſts of three or four. The young otters are leſs handſome than the old; and M. Buffon looks upon the otters in general to be very ſtupid animals. He will not allow them the capacity and inſtinct commonly aſcribed to them by other naturaliſts; ſuch

Plate CLXXXIV. fig. 4.

Mustela such as that of always ascending the rivers, in order to swim the more easily down the current, when loaded with his prey; of fitting up, and flooring his house to exclude the water; of hoarding a store of fishes in case of a scarcity; and lastly, of being easily tamed, of fishing for his master, and even bringing the fish into the kitchen. "All I know (says our author) is, that the otters dig no habitations for themselves; that they take possession of the first hole they find, under the roots of poplars or willows, in the clefts of rocks, and even in piles of floating wood; that they deposit their young on beds made of twigs and herbs; that we find, in their habitations, heads and bones of fishes; that they often change their places of abode; that they banish their young at the end of six weeks or two months; that those I endeavoured to tame attempted to bite, though they were only taking milk, and unable to eat fish; that, some days after, they became more gentle, perhaps because they were weak or sick; that, so far from being easily accustomed to a domestic life, all of them which I attempted to bring up died young; that the otter is naturally of a savage and cruel disposition; that when he gets into a fish-pond, he is equally destructive as the pole-cat in a hen-house; that he kills many more fishes than he can eat, and carries one off in his mouth."

On the other hand, Mr Pennant tells us, that the otter shows great sagacity in forming its habitation: it burrows underground on the banks of some river or lake: it always makes the entrance of its hole under water; working upwards to the surface of the earth, and forming, before it reaches the top, several holes or lodges, that, in case of high floods, it may have a retreat; for no animal affects lying drier at top: it makes a minute orifice for the admission of air. It is further observed, that this animal, the more effectually to conceal its retreat, contrives to make even this little air-hole in the middle of some thick bush. Our author also informs us, that the otter is capable of being tamed; that he will follow his master like a dog, and even fish for him, and return with his prey.

Though the otter does not cast his hair, his skin is browner, and sells dearer, in winter than in summer; and makes a very fine fur. His flesh has a disagreeable fishy taste. His retreats exhale a noxious odour from the remains of putrid fishes; and his own body has a bad smell. The dogs chace the otter spontaneously, and easily apprehend him when at a distance from water or from his hole. But, when seized, he defends himself; bites the dogs most cruelly, and sometimes with such force as to break their leg-bones, and never quits his hold but with life. The beaver, however, who is not a very strong animal, pursues the otters, and will not allow them to live on the same banks with himself.

Mr Pennant mentions an account of some Newfoundland animals, communicated to him by Mr Banks, which he supposes to have been of the otter kind. He observed, sitting on a rock near the mouth of a river, five animals shaped like Italian gre-hounds, bigger than a fox; of a shining black colour, with long legs, and a long taper tail. They often leaped into the water, and brought up trouts, which they gave to their young which were sitting by them. On perceiving him they all took to the water, and swam a little way from shore, keeping their heads out of the water, and looking at him. An old furrier said, that he remembered the skin of one sold for five guineas; and that the French often see them in Hare-bay. According to some authors, there are otters in Cayenne which weigh 90 and 100 pounds. They live in the great and unfrequented rivers, and their heads often appear above water. Their cry is heard at great distances; their hair is very soft, but shorter than that of the beaver, and generally of a brown colour. They live upon fish, and eat likewise the grains which fall into the water from the banks of the rivers. In Guiana, according to M. de la Borde, the otters are very numerous along the rivers and marshes where fishes abound. They sometimes appear in such numbers, and are so fierce, that they cannot be approached. They litter in holes which they dig in the banks; they are often tamed and brought up in houses.

3. The lutreola, or small otter, has hairy palmated feet, and a white mouth, the same form with an otter, but thrice as small. It inhabits Poland and the north of Europe; lives on fish, frogs, and water-insects: its fur is very valuable, next to the sable; is caught in Baskiria with dogs and traps; is exceedingly fœtid. This is the same animal with the minx of America, which, Mr Collinson tells us, frequents the water like the otter, and very much resembles it in shape and colour, but is less; it leaves its watery haunts to come and rob hen-roosts; it bites off the heads of the poultry, and sucks their blood; when vexed, it has a strong loathsome smell; its length from nose to tail 20 inches, the tail four: is of a shining dark-brown colour. M. Buffon mentions, from M. de la Borde, a kind of otter which he calls the *small fresh-water otter of Cayenne*, and which is only seven inches long from the end of the nose to the extremity of the body. The tail of this small otter has no hair: its length is six inches seven lines, and five lines thick at the origin, diminishing gradually to the extremity, which is white, though the rest of the tail is brown; and, in place of hair, it is covered with a rough granulated skin, like shagreen; it is flat below, and convex above. All the under part of the body and head, as well as the fore-part of the fore-legs, is white. The top and sides of the head and body are marked with large brownish-black spots, and the intervals are of a yellowish grey colour. The black spots correspond on each side of the body, and there is a white spot above each eye.

4. The barbata, or Guinea-weasel, is of a reddish colour; and the toes are not connected with a membrane: he is of a black colour, with coarse hair of the size of a martin; digs an habitation in the earth with his fore-feet, in which he has great strength, and which are much shorter than those behind. It inhabits Guinea, Brasil, and Guiana: when it rubs itself against trees, it leaves behind an unctuous matter that smells of musk. It is very fierce; and, if driven to necessity, will fly at man or beast: it is very destructive to poultry.

5. The gulo, or glutton, is of a dusky red colour, and blackish on the middle of the back: it is a most voracious animal; but very slow of foot, so is obliged to take its prey by surprise. In America it is called the *beaver-eater*; because it watches those animals as they come out of their houses, and sometimes breaks into their habitations and devours them. It often lurks on

trees, and falls on the quadrupeds that pass under; will fasten on a horse, elk, or stag, and continue eating a hole into its body, till the animal falls down with pain, or else will tear out its eyes: no force can disengage it; yet sometimes the deer, in their agony, have been known to destroy the glutton by running its head violently against a tree. This animal also devours the isatis, or white fox; searches for the traps laid for the sables and other animals, and is often beforehand with the huntsmen, who sustain great loss by the glutton. Authors have pretended, that it feeds so voraciously, that at length it is in danger of bursting; and that it is obliged to ease itself of its load, by squeezing it out between two trees: but this is not well authenticated. Mr Buffon acquaints us, that a glutton which he kept for 18 months at Paris, became so tame that it discovered no ferocity, and did not injure any person. "His voracity (says he) has been as much exaggerated as his cruelty. He indeed eat a great deal; but, when deprived of food, he was not importunate. He is two feet two inches long, from the point of the nose to the origin of the tail. The muzzle, and as far as the eye-brows, is black. The eyes are black and small. From the eye-brows to the ears, the hair is a mixture of white and brown. Below the under-jaw, as well as between the fore-feet, the hair is spotted with white. The length of the fore-legs is 11 inches, and that of the hind-legs one foot. The tail, including four inches of hair at its extremity, is eight inches long. The four legs, the tail, and the back, as well as the belly, are black. His fore-feet, from the heel to the extremity of the claws, are three inches nine lines in length: the five claws are very crooked and well separated. The middle claw is an inch and an half in length. He avoids water; and dreads horses, and men dressed in black. He walks by a kind of leap, and eats pretty voraciously. After taking a full meal, he covers himself in his cage with straw. When drinking, he laps like a dog. He utters no cry. After drinking, with his paws he throws the remainder of the water on his belly. He is almost perpetually in motion. If allowed, he would devour more than four pounds of flesh every day. He eats no bread; and devours his food so voraciously, and almost without chewing, that he is apt to choke himself."

The glutton is common in most of the northern regions of Europe, and even of Asia; but in Norway, according to Pontoppidan, he is chiefly confined to the diocese of Drontheim. The same author remarks, that the skin of the glutton is very valuable; that he is not shot with fire-arms, to prevent his skin from being damaged; and that the hair is soft, and of a black colour, shaded with brown and yellow. In Siberia the skin is sold for 4*s*. or 6*s*.; at Jakutsk for 12*s*.; and in Kamtschatka still dearer, because the women there dress their hair with its paws, which they esteem a great ornament: the fur is greatly esteemed in Europe; and those produced in the north of Europe and Asia are much preferable to the American kind. In its wild state, Mr Pennant informs us, that the glutton is vastly fierce; a terror both to the wolf and bear, which will not prey upon it when they find it dead; perhaps on account of its being so very fœtid that it smells like a pole-cat: it makes a strong resistance when attacked; will tear the stock from the gun, and pull the traps in which it is caught to pieces: notwithstanding which, it is capable of being tamed, and of learning several tricks. M. Buffon remarks, that though the glutton employs considerable art and address in seizing other animals, he seems to possess no other talents but those which relate to appetite. "It would (says he) appear, that the glutton even wants the common instinct of self-preservation. He allows himself to be approached by men, or comes up to them without betraying the smallest apprehension." This indifference, which seems to be the effect of imbecillity, proceeds perhaps from a different cause. It is certain that the glutton is not stupid, since he finds means to satisfy his appetite, which is always vehement and pressing. Neither is he deficient in courage, since he indiscriminately attacks all animals he meets with, and betrays no symptoms of fear at the approach of men. Hence, if he wants attention to himself, it proceeds not from indifference to his own preservation, but from the habit of security. As he lives in a country which is almost desart, he seldom sees man, who are his only enemies. Every time he tries his strength with other animals, he finds himself their superior. He goes about with perfect confidence; and never discovers the smallest mark of fear, which always supposes some experience of weakness. Of this we have an example in the lion, who never turns away from man, unless he has experienced the force of his arms: and the glutton, trailing along the snows of his desart climate, remains always in perfect safety, and reigns, like the lion, not so much by his own strength, as by the weakness of the animals around him.

6. The martes, or martin, is of a blackish yellow colour, with a pale throat, and the toes are not webbed. These animals are found in great numbers in all temperate countries, and even in warm regions, as in Madagascar and the Maldivia islands, and are never seen in high latitudes. The martin has a fine countenance, a lively eye, supple limbs, and a flexible body. His movements are all exceedingly nimble; he rather bounds and leaps than walks. He climbs rough walls with ease and alacrity; enters the pigeon or hen-houses, eats the eggs, pigeons, fowls, &c. and the female often kills great numbers, and transports them to her young. He likewise seizes mice, rats, moles, and birds in their nests. M. Buffon kept one of these animals for a considerable time. He tamed to a certain degree, but never formed any attachment, and continued always so wild, that it was necessary to chain him. He made war against the rats, and attacked the poultry whenever they came in his way. He often got loose, though chained by the middle of the body. At first he went to no great distance, and returned in a few hours; but without discovering any symptoms of joy, or affection to any particular person. He, however, called for victuals like a cat or a dog. Afterwards he made longer excursions; and at last he thought proper never to return. He was then about a year and a half old, seemingly the age at which nature assumes her full ascendency. He eat every thing presented to him, except sallad and herbs; was fond of honey, and preferred hemp-seed to every other grain. It was remarked that he drank very often; that he sometimes slept two days successively, and at other times would sleep none for two or three days; that, before sleep-

ing,

Mustela. ing, he folded himself in a round form, and covered his head with his tail; and that, while awake, his motions were so violent, so perpetual, and so incommodious, that, though he had not disturbed the fowls, it was necessary to chain him, to prevent him from breaking every thing. The same author informs us, that he has had in his possession several martins of a more advanced age, which had been taken in nets; but they continued to be totally savage, bit all who attempted to touch them, and would eat nothing but raw flesh.

Martins, it is said, go with young as long as cats. We meet therefore with young ones from spring to autumn; and therefore it is probable they bring forth more than once a-year. The younger females bring only three or four at a time; but the more aged produce six or seven. When about to bring forth, they take up their abode in magazines of hay, in holes of walls, which they stuff with straw and herbs; in clefts of rocks; or in the hollow trunks; and when disturbed, they remove their young, who seem very soon to arrive at maturity; for the one which M. Buffon brought up, had nearly attained its full growth in one year. The martin has an agreeable musky odour, which proceeds from a matter contained in two vesicles, one on each side of the extremity of the rectum. The skin is a valuable fur, and much used for linings to the gowns of magistrates.

Plate CLXXXV. fig. 1. 7. The putorius, pole-cat, or fitchet, has unconnected toes, is of a dirty yellow colour, with a white mouth and ears. He is a native of most parts of Europe; and has a great resemblance to the martin in temperament, manners, disposition, and figure. Like the latter, he approaches our habitations, mounts on the roofs, takes up his abode in hay-lofts, barns, and unfrequented places, from which he issues during the night only in quest of prey. He burrows under ground, forming a shallow retreat about two yards in length, generally terminating under the roots of some large tree. He makes greater havock among the poultry than the martin, cutting off the heads of all the fowls, and then carrying them off one by one to his magazine. If, as frequently happens, he cannot carry them off entire, on account of the smallness of the entry to his hole, he eats the brains, and takes only the heads along with him. He is likewise very fond of honey, attacks the hives in winter, and forces the bees to abandon them. The females come in season in the spring; and bring forth three, four, or five at a time, but does not lead them off till the end of summer. The pole-cat is excessively fetid; yet the skin is dressed with the hair on, and used as other furs, for tippets, &c. and is also sent abroad to line cloaths. This creature seems to be confined to the temperate climates; few or none being found in the northern regions, or in the torrid zone. In Europe, his territories seem to extend only from Poland to Italy. It is certain that he avoids the cold, for in winter he retires into the houses; and he is perhaps equally averse from great heat.

Fig. 2. 8. The furo, or ferret, has red eyes, and unconnected toes; the colour of the whole body is of a very pale yellow; the length from nose to tail is about 14 inches, the tail five. In its wild state it inhabits Africa; from whence it was originally brought into Spain, in order to free that country from multitudes of rabbits with which it was over-run; and from thence the rest of Europe was supplied with it. This creature is incapable of bearing the cold, and cannot subsist even in France unless in a domestic state. The ferret is not in our climates endowed with the same capacity of finding his subsistence as other wild animals, but must be carefully nourished within doors, and cannot exist in the fields; for those who are lost in the burrows of rabbits never multiply, but probably perish during the winter. Like other domestic animals, he varies in colour. The female ferret is less than the male; and when in season, we are assured, she is so extremely ardent, that she dies if her desires are not gratified. Ferrets are brought up in casks or boxes, where they are furnished with beds of hemp or flax. They sleep almost continually. Whenever they awake, they search eagerly for food; and brawn, bread, milk, &c. are commonly given them. They produce twice every year; and the female goes six weeks with young. Some of them devour their young as soon as they are brought forth, instantly come again in season, and have three litters, which generally consist of five or six, and sometimes of seven, eight, or nine. This animal is by nature a mortal enemy to the rabbit. Whenever a dead rabbit is for the first time presented to a young ferret, he flies upon it, and bites it with fury; but if it be alive, he seizes it by the throat or the nose, and sucks its blood. When let into the burrows of rabbits, he is muzzled, that he may not kill them in their holes, but only oblige them to come out, in order to be caught in the nets. If the ferret is let in without a muzzle, he is in danger of being lost: for, after sucking the blood of the rabbit, he falls asleep; and even smoking the hole is not a certain method of recalling him; because the holes have often several entries which communicate with each other, and the ferret retires into one of those when incommoded with the smoke. Boys likewise use the ferret for catching birds in the holes of walls, or of old trees. The ferret, tho' easily tamed, and rendered docile, is extremely irascible: his odour is always disagreeable; but when he is irritated, it becomes much more offensive. His eyes are lively, and his aspect is inflammatory; all his movements are nimble; and he is at the same time so vigorous, that he can easily master a rabbit, tho' at least four times larger than himself.

9. The zibellina, or sable, has divided toes: the body is of a dusky yellow colour, with a white forehead, and an ash-coloured throat. It is found in Tartary and the northern parts of Asia. The sables inhabit the banks of rivers, and the thickest parts of the woods. They leap with great agility from tree to tree; and avoid the rays of the sun, which are said in a short time to change the colour of their hair. They live in holes of the earth, or beneath the roots of trees: sometimes they will form nests in the trees, and skip with great agility from one to the other: they are very lively, and much in motion during the night. Mr Gmelin tells us, that after eating they generally sleep half an hour or an hour, when they may be pushed, shaken, and even pricked, without awaking. During the night they are excessively active and restless: a tame one kept by Mr Gmelin was accustomed to rise upon its hind-legs, on sight of a cat, in order to prepare for the combat. During summer the

the fables prey on ermines, weafels, and fquirrels, but efpecially on hares; in winter, on birds; in autumn, on hurtleberries, cranberries, and the berries of the fervice-tree: but during that feafon their fkins are at the worft; that diet caufing their fkins to itch, and to rub off their fur againft the trees: they bring forth at the end of March or beginning of April, and have from three to five at a time, which they fuckle for four or five weeks. Their chafe was, in the more barbarous times of the Ruffian empire, the employ, or rather the tafks, of the unhappy exiles into Siberia: as that country is now become more populous, the fables have in great meafure quitted it, and retired farther north and eaft, to live in defart forefts and mountains: they live near the banks of rivers, or in the little iflands in them: on this account they have, by fome, been fuppofed to be the Σαϐεριον of Ariftotle, (*Hift. An. lib.* viii. *c.* 5.) which he claffes with the animals converfant among waters.

At prefent the hunters of fables form themfelves into troops, from 5 to 40 each: the laft fubdivide into leffer parties, and each choofes a leader; but there is one that directs the whole: a fmall covered boat is provided for each party, loaden with provifions, a dog and net for every two men, and a veffel to bake their bread in: each party alfo has an interpreter for the country they penetrate into: every party then fets out according to the courfe their chief points out: they go againft the ftream of the rivers, drawing their boats up, till they arrive in the hunting country; there they ftop, build huts, and wait till the waters are frozen, and the feafon commences: before they begin the chafe, their leader affembles them, they unite in a prayer to the Almighty for fuccefs, and then feparate: the firft fable they take is called *God's fable*, and is dedicated to the church.

They then penetrate into the woods; mark the trees as they advance, that they may know their way back; and in their hunting-quarters form huts of trees, and bank up the fnow round them: near thefe they lay their traps; then advance farther, and lay more traps, ftill building new huts in every quarter, and return fucceffively to every old one to vifit the traps and take out the game to fkin it, which none but the chief of the party muft do: during this time they are fupplied with provifions by perfons who are employed to bring it on fledges, from the places on the road, where they are obliged to form magazines, by reafon of the impracticability of bringing quantities through the rough country they muft pafs. The traps are a fort of pitfall, with a loofe board placed over it, baited with fifh or flefh: when fables grow fcarce, the hunters trace them in the new-fallen fnow, to their holes; place their nets at the entrance; and fometimes wait, watching two or three days for the coming out of the animal: it has happened that thefe poor people have, by the failure of their provifions, been fo pinched with hunger, that, to prevent the cravings of appetite, they have been reduced to take two thin boards, one of which they apply to the pit of the ftomach, the other to the back, drawing them tight together by cords placed at the ends: fuch are the hardfhips our fellow-creatures undergo, to fupply the wantonnefs of luxury.

The feafon of chace being finifhed, the hunters reaffemble, make a report to their leader of the number of fables each has taken; make complaints of offenders againft their regulations; punifh delinquents; fhare the booty; then continue at the head-quarters till the rivers are clear of ice; return home, and give to every church the dedicated furs.

10. The vulgaris, or foumart (A), is the leaft of the weafel kind; the length of the head and body not exceeding fix, or at moft feven inches. The tail is only two inches and an half long, and ends in a point; the ears are large; and the lower parts of them are doubled in. The whole upper part of the body, the head, tail, legs, and feet, are of a very pale tawny brown. The whole under fide of the body from the chin to the tail is white; but beneath the corners of the mouth, on each jaw, is a fpot of brown. It is very deftructive to young birds, poultry, and young rabbits; and is befides a great devourer of eggs. It does not eat its prey on the place; but, after killing it by one bite near the head, carries it off to its young, or to its retreat. It preys alfo on moles, as appears by its being fometimes caught in the mole-traps. It is a remarkably active animal; and will run up the fides of walls with fuch eafe, that fcarce any place is fecure from it; and the body is fo fmall, that there is fcarce any hole but what is pervious to it. This fpecies is much more domeftic than any of the reft, and frequents out-houfes, barns, and granaries. It clears its haunts in a fhort time from mice and rats, being a much greater enemy to them than the cat itfelf. In fummer, however, they retire farther from houfes, efpecially into low grounds, about mills, along rivulets, concealing themfelves among brufh-wood, in order to furprife birds; and often take up their abode in old willows, where the female brings forth her young. She prepares for them a bed of ftraw, leaves, and other herbage, and litters in the fpring; bringing from three to five at a time. The young are born blind; but foon acquire fight, and ftrength fufficient to follow their mothers. Their motion confifts of unequal and precipitant leaps; and when they want to mount a tree, they make a fudden bound, by which they are at once elevated feveral feet high. They leap in the fame manner when they attempt to feize a bird.

Thefe creatures, as well as the pole-cat and ferret, have a difagreeable odour, which is ftronger in fummer than in winter; and when purfued or irritated, their fmell is felt at a confiderable diftance. They move always with caution and filence, and never cry but when they are hurt. Their cry is fharp, rough, and very expreffive of refentment. As their own odour is offenfive, they feem not to be fenfible of a bad fmell in other bodies. M. Buffon informs us, that a peafant in his neighbourhood took three new-littered weafels out of the carcafe of a wolf that had been hung up on a tree by the hind-feet. The wolf was almoft entirely putrefied, and the female weafel had made a neft of leaves and herbage for her young in the thorax of this putrid carcafe. The weafel may be perfectly tamed, and

(A) This animal is confounded by Linnæus with the ftoat or ermine. He feems unacquainted with our weafel in its brown colour; but defcribes it in its white ftate under the title of *fnoxucs*, or *muftela nivalis*. Mr Pennant met with it in that circumftance in the Ifle of Ilay.

and rendered as caressing and frolicksome as a dog or squirrel. The method of taming them is to stroke them often and gently over the back; and to threaten, and even to beat them when they bite. In the domestic state their odour is never offensive but when irritated. They are fed with milk, boiled flesh, and water.

Plate CLXXXV. fig. 3.

11. The candida, stoat, or ermine, is ten inches long from the nose to the origin of the tail; the tail itself is five inches and a half long. The colours bear so near a resemblance to those of the weasel, as to cause them to be confounded together by the generality of common observers; the weasel being usually mistaken for a small stoat: but these animals have evident and invariable specific differences, by which they may be easily known. First, by the size; the weasel being ever less than the stoat: secondly, the tail of the latter is always tipt with black, is longer in proportion to the bulk of the animal, and more hairy; whereas the tail of the weasel is shorter, and of the same colour with the body: thirdly, the edges of the ears and the ends of the toes in this animal are of a yellowish white. It may be added, that the stoat haunts woods, hedges, and meadows, especially where there are brooks whose sides are covered with small bushes; and sometimes (but less frequently than the weasel) inhabits barns, and other buildings.

In the most northern parts of Europe, these animals regularly change their colour in winter; and become totally white, except the end of the tail, which continues invariably black; and in that state are called *ermines:* we are informed that the same is observed in the Highlands of Scotland. The skins and tails are a very valuable article of commerce in Norway, Lapland, Russia, and other cold countries; where they are found in prodigious numbers. They are also very common in Kamtschatka and Siberia. In Siberia they burrow in the fields, and are taken in traps baited with flesh. In Norway they are either shot with blunt arrows, or taken in traps made of two flat stones, one being propped up with a stick, to which is fastened a baited string, which when the animals nibble, the stone falls down and crushes them to death. The Laplanders take them in the same manner, only instead of stones make use of two logs of wood. The stoat is sometimes found white in Great Britain, but not frequently: and then it is called a *white weasel.* That animal is also found white; but may be easily distinguished from the other in the ermine state, by the tail, which in the weasel is of a light tawny brown. With us the former is observed to begin to change its colour from brown to white in November, and to begin to resume the brown the beginning of March.

The natural history of this creature is much the same with that of the weasel; its food being birds, rabbits, mice, &c. its agility the same, and its scent equally fetid: it is much more common in England than that animal.

MUSTER, in a military sense, a review of troops under arms, to see if they be complete and in good order; to take an account of their numbers, the condition they are in, viewing their arms and accoutrements, &c.

Muster-*Master-general,* or *Commissary-general of the* Musters; one who takes account of every regiment, their number, horses, arms, &c. reviews them, sees the horses be well mounted, and all the men well armed and accoutred, &c.

Muster-*Rolls,* lists of soldiers in each company, troop, or regiment, by which they are paid, and the strength of the army is known.

MUTE, in a general sense, signifies a person that cannot speak, or has not the use of speech.

Mute, in law, a person that stands dumb or speechless, when he ought to answer, or to plead. See Arraignment.

Mute, in grammar, a letter which yields no sound without the addition of a vowel. The simple consonants are ordinarily distinguished into mutes and liquids, or semi-vowels. See the articles Consonant, Liquid, &c.

The mutes in the Greek alphabet are nine, three of which, *viz.* π, κ, τ, are termed *tenues;* three β, γ, δ, termed *mediæ,* and three φ χ, θ, termed *aspirates.* See the article Aspirate, &c.

The mutes of the Latin alphabet are also nine, *viz.* B, C, D, G, I, K, P, Q, T.

MUTILATION, the retrenching or cutting away any member of the body.

This word is also extended to statues and buildings, where any part is wanting, or the projecture of any member, as a corniche or an impost, is broken off. It is sometimes also used, in a more immediate manner, for castration.

MUTILLA, in zoology, a genus of animals belonging to the order of insecta hymenoptera. There are 10 species; the most remarkable of which is the occidentalis, or velvet-ant, an inhabitant of North America. It has six legs, with short crooked antennæ; the abdomen large, with a black list crossing the lower part of it, and another black spot at the joining of the thorax; excepting which, the whole body and head resembles crimson-velvet. The trunk or shell of the body is of such a strong and hard contexture, that, tho' trod upon by men and cattle, they receive no harm. They have a long sting in their tails, which causes inflammation and great pain, for half an hour, to those who are stung by them; which usually happens to negroes and others that go barefooted. They are mostly seen running very nimbly on sandy roads in the hottest summer-weather; and always single. What they feed on, in what manner they breed, and where they secure themselves in winter, is unknown.

Plate CLXXXII. fig. 3.

MUTINY, in a military sense, to rise against authority.—"Any officer or soldier who shall presume to use traiterous or disrespectful words against the sacred person of his majesty, or any of the royal family, is guilty of mutiny.

Articles of War.

"Any officer or soldier who shall behave himself with contempt or disrespect towards the general or other commander in chief of our forces, or shall speak words tending to their hurt or dishonour, is guilty of mutiny.

"Any officer or soldier who shall begin, excite, cause, or join in, any mutiny or sedition, in the troop, company, or regiment, to which he belongs, or in any other troop or company in our service, or on any party, post, detachment, or guard, on any pretence whatsoever, is guilty of mutiny.

"Any

" Any officer or ſoldier who, being preſent at any mutiny or ſedition, does not uſe his utmoſt endeavours to ſuppreſs the ſame, or coming to the knowledge of any mutiny, or intended mutiny, does not without delay give information to his commanding officer, is guilty of mutiny.

" Any officer or ſoldier, who ſhall ſtrike his ſuperior officer, or draw, or offer to draw, or ſhall lift up any weapon, or offer any violence againſt him, being in the execution of his office, on any pretence whatſoever, or ſhall diſobey any lawful command of his ſuperior officer, is guilty of mutiny."

MUTINY-*Act*. See MILITARY-*State*.

MUTIUS (Caius), ſurnamed *Codrus*, and afterwards *Scævola*, was one of the illuſtrious Roman family of the Mutians, and rendered his name famous in the war between Porſenna king of Tuſcany and the Romans. That prince reſolving to reſtore the family of Tarquin the Proud, went to beſiege Rome 507 B. C. Mutius reſolved to ſacrifice himſelf for the ſafety of his country; and boldly entering the enemy's camp, killed Porſenna's ſecretary, whom he took for Porſenna himſelf. Being ſeized and brought before Porſenna, he told him boldly, that 300 young men like himſelf had ſworn to murder him; *but ſince this hand has miſſed thee*, continued he, *it muſt be puniſhed;* then putting his right hand on the burning coals, he let it burn with ſuch a conſtancy as amazed the beholders. The king, amazed at the intrepidity of this young Roman, ordered that he ſhould have his freedom and return to Rome, and ſoon after concluded a peace with the Romans. From this action Mutius obtained the ſurname of *Scævola*, or " left-handed," which was enjoyed by his family.

MUTIUS *Scævola* (*Q.*), ſurnamed the *Augur*, was an excellent civilian, and inſtructed Cicero in the laws. He was made prætor in Aſia; was afterwards conſul, and performed very important ſervices for the republic.

He ought not to be confounded with Quintus Mutius Scævola, another excellent civilian, who was prætor in Aſia, tribune of the people, and at length conſul, 95 B. C. He governed Aſia with ſuch prudence and equity, that his example was propoſed to the governors who were ſent into the provinces. Cicero ſays, " that he was the moſt eloquent orator of all the civilians, and the moſt able civilian of all the orators." He was aſſaſſinated in the temple of Veſta, during the wars of Marius and Sylla, 82 B. C.

MUTTON, the common name of the fleſh of a ſheep after the animal has been killed. Mutton has been commonly preferred to all the fleſhes of quadrupeds. And indeed, beſides its being more perfect, it has the advantage over them of being more generally ſuited to different climates: whereas beef, *e. g.* requires a very nice intermediate ſtate, which it ſeems to enjoy chiefly in England; for although Scotland ſupplies what are reckoned the beſt cattle, it is in the rich Engliſh paſtures that they are brought to perfection. Now the ſheep can be brought almoſt to the ſame perfection in this bleak northern region as in the ſouthern countries.

MUTULE, in architecture, a kind of ſquare modillion ſet under the corniche of the Doric order.

MUZZLE *of a* GUN *or* MORTAR, the extremity at which the powder and ball is put in; and hence the muzzle-ring is the metalline circle or moulding that ſurrounds the mouth of the piece.

MYA, the GAPER, in zoology; a genus belonging to the order of vermes teſtacea, the characters of which are theſe. It has a bivalve ſhell gaping at one end; the hinge, for the moſt part, furniſhed with a thick, ſtrong, and broad tooth, not inſerted into the oppoſite valve. Its animal is an ASCIDIA. The moſt remarkable ſpecies are, Plate CLXXVI.

1. The declivis, or ſloping mya, with a brittle half-tranſparent ſhell, with a hinge ſlightly prominent near the open, and ſloping downwards. It is frequent about the Hebrides; the fiſh eaten by the gentry.

2. The mya pictorum, hath an oval brittle ſhell, with a ſingle longitudinal tooth like a lamina in one ſhell, and two in the other; the breadth is a little above two inches, the length one. It inhabits rivers; the ſhells are uſed to put water-colours in, whence the name. Otters feed on this and the other freſh-water ſhells.

3. The margaritifera, or pearl mya, hath a very thick, coarſe, opaque ſhell; often much decorticated; oblong, bending inward on one ſide, or arcuated; black on the outſide; uſual breadth from five to ſix inches, length two and a quarter. It inhabits great rivers, eſpecially thoſe which water the mountainous parts of Great Britain. See Plate CLXXVI. fig. 18.

This ſhell is noted for producing quantities of pearl. There have been regular fiſheries for the ſake of this precious article in ſeveral of our rivers. Sixteen have been found within one ſhell. They are the diſeaſe of the fiſh, analogous to the ſtone in the human body. On being ſqueezed, they will eject the pearl, and often caſt it ſpontaneouſly in the ſand of the ſtream. The Conway was noted for them in the days of Cambden. A notion alſo prevails, that Sir Richard Wynne of Gwydir, chamberlain to Catharine queen to Charles II. preſented her majeſty with a pearl (taken in this river) which is to this day honoured with a place in the regal crown. They are called by the Welſh *cregin diluw*, or " deluge ſhells," as if left there by the flood. The Irt in Cumberland was alſo productive of them. The famous circumnavigator, Sir John Hawkins, had a patent for fiſhing in that river. He had obſerved pearls plentiful in the Straits of Magellan, and flattered himſelf with being enriched by procuring them within his own iſland. In the laſt century, ſeveral of great ſize were gotten in the rivers of the counties of Tyrone and Donegal in Ireland. One that weighed 36 carats was valued at 40l.; but being foul, loſt much of its worth. Other ſingle pearls were ſold for 4l. 10s. and even for 10l. The laſt was ſold a ſecond time to Lady Glenlealy, who put it into a necklace, and refuſed 80l. for it from the ducheſs of Ormond.

Suetonius reports, that Cæſar was induced to undertake his Britiſh expedition for the ſake of our pearls; and that they were ſo large that it was neceſſary to uſe the hand to try the weight of a ſingle one. Mr Pennant ſuppoſes that Cæſar only heard this by report; and that the cryſtalline balls called *mineral pearl*, were miſtaken for them.

We

We believe that Cæſar was diſappointed of his hope: yet we are told that he brought home a buckler made with Britiſh pearl, which he dedicated to, and hung up in, the temple of Venus Genetrix: a proper offering to the goddeſs of beauty, who ſprung from the ſea. It may not be improper to mention, that notwithſtanding the claſſics honour our pearl with their notice, yet they report them to have been ſmall and ill-coloured, an imputation that in general they are ſtill liable to. Pliny ſays, that a red ſmall kind was found about the Thracian Boſphorus, in a ſhell called *mya;* but does not give it any mark to aſcertain the ſpecies.

MYAGRUM, Gold of pleasure; a genus of the ſiliculoſa order, belonging to the tetradyminaua claſs of plants. There are five ſpecies; but the only remarkable one is the ſativum, which grows naturally in corn-fields in the ſouth of France and Italy, and alſo in ſome parts of Britain. It is an annual plant, with an upright ſtalk a foot and an half high, ſending out two or four ſide-branches, which grow erect; the flowers grow in looſe ſpikes at the end of the branches, ſtanding upon ſhort footſtalks an inch long: they are compoſed of four ſmall yellowiſh petals, placed in form of a croſs; theſe are ſucceeded by oval capſules, which are bordered and crowned at the top with the ſtyle of the flower, having two cells filled with red ſeeds. This is cultivated in Germany for the ſake of the expreſſed oil of the ſeeds, which the inhabitants uſe for medicinal, culinary, and œconomical purpoſes. The ſeeds are a favourite food with geeſe. Horſes, goats, ſheep, and cows, eat the plant.

MYCENÆ, (Homer); a town of Argolis; formerly the capital, and the royal reſidence of Agamemnon, fifty ſtadia to the north of Argos, celebrated by the poets. After the war of Troy, on the extinction of Agamemnon's kingdom, it fell to ſuch decay, that in Strabo's time there was not ſo much as a trace of it remaining: but that, in the Macedonian war carried on by the Romans, there was ſomething of a town, is plain from the *Excerpta* of Polybius, to whom add Livy. It was famous for its breed of horſes. (Virgil, Horace).

MYCONE, an iſland of the Archipelago, ſituated in E. Long. 25. 51. N. Lat. 37. 28. It is about 36 miles in circuit; and has a town of the ſame name, containing about 3000 inhabitants. The people of this iſland are ſaid to be the beſt ſailors in the Archipelago, and have about 150 veſſels of different ſizes. The iſland yields a ſufficient quantity of barley for the inhabitants, and produces abundance of figs, and ſome olives; but there is a ſcarcity of water, eſpecially in ſummer, there being but one well on the iſland. There are a great number of churches and chapels, with ſomes monaſteries. The dreſs of the women in this iſland is very remarkable, and as different from that of the other iſlands as that of thoſe iſlanders is different from the dreſs of the other European ladies. Their heads are adorned with lively-coloured turbans; their garments are a ſhort white ſhift plaited before and behind, which reaches to their knees; they have white linen-drawers, and red, green, yellow, or blue ſtockings, with various coloured ſlippers. An ordinary ſuit for the better ſort will coſt 200 crowns.

MYGDONIA, (anc. geog.) a diſtrict of Macedonia, to the north of the Sinus Thermaicus, and eaſt of the river Axius, which ſeparates it from Bottiæis, and weſt of the river Strymon, (Pliny). Alſo a diſtrict of Meſopotamia, which took its name from that of Macedonia, running along the Euphrates, from Zeugma down to Thapſacus; extending a great way eaſt, becauſe Niſibis was reckoned to it.

MYLOGLOSSUM, in anatomy. See Anatomy, *Table of the Muſcles*.

MYLOHYOIDÆUS. *Ibid.*

MYOPIA, Short-sightedness, a ſpecies of viſion wherein objects are ſeen only at ſmall diſtances. See Medicine, n° 178.

MYOSOTIS, Scorpion-grass; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are four ſpecies; of which the moſt remarkable is the ſcorpioides, or mouſe-ear. This is a native of Britain, growing naturally in dry fields, and on the margins of ſprings and rills. It hath naked ſeeds, and the points of the leaves callous. It varies conſiderably in different ſituations. In dry places the plant and flowers are ſmaller; in moiſt ones both are larger, and ſometimes hairy. The bloſſoms vary from a full blue to a very pale one, and ſometimes a yellow; and appear in a long ſpirally twiſted ſpike. When it grows in the water, and its taſte and ſmell is thereby rendered leſs obſervable, ſheep will ſometimes eat it; but it is generally fatal to them. Cows, horſes, ſwine, and goats, refuſe it.

MYRIAD, a term ſometimes uſed to denote ten thouſand.

MYRICA, Gale, or Sweet-willow, in botany; a genus of the tetrandria order, belonging to the diœcia claſs of plants.

Species. 1. The gale, or ſweet-willow, grows naturally in many places both of Scotland and England. It riſes near four feet high, with many ſhrubby ſtalks, which divide into ſeveral ſlender branches, garniſhed with ſtiff ſpear-ſhaped leaves of a light yellowiſh green, ſmooth, and a little ſawed at their points; and emit a fragrant odour when bruiſed. The female flowers or catkins are produced from the ſides of the branches, growing upon ſeparate plants from the female, which are ſucceeded by cluſters of ſmall berries, each having a ſingle ſeed. It flowers in July, and ripens in autumn. 2. The ceriſera, or candleberry gale, is a native of North America. It is a ſmall tree or ſhrub about twelve feet high, with crooked ſtems branching forth near the ground irregularly. The leaves are long, narrow, and ſharp-pointed. Some trees have moſt of their leaves ſerrated, others not. In May, the ſmall branches are alternately and thick ſet with oblong tufts of very ſmall flowers, reſembling in form and ſize the catkins of the hazel-tree, coloured with red and green. Theſe are ſucceeded by ſmall cluſters of blue berries cloſe connected, like bunches of grapes. The kernel is incloſed in an oblong, hard ſtone, incruſted over with an unctuous mealy ſubſtance, from which the wax is procured in the following manner: in November and December, when the berries are ripe, a man with his family will remove from home to ſome iſland or ſand-bank near the ſea, where theſe trees moſt abound, taking with them kettles to boil the berries in. He builds a hut with palmetto-leaves for the ſhelter of himſelf

Myrmecophaga. himſelf and family during his reſidence there, which is commonly for four or five weeks. The man cuts down the trees, while the children ſtrip off the berries into a porridge-pot; and having put water to them, they boil them till the oil floats, which is then ſkimmed off into another veſſel. This is repeated till no more oil appears. When cold, this hardens to the conſiſtence of wax, and is of a dirty green colour. Then they boil it again, and clarify it in braſs kettles; which gives it a tranſparent greenneſs. Theſe candles burn a long time, and yield a grateful ſmell. They uſually add a fourth part of tallow, which makes them burn clearer.

MYRMECOPHAGA, or ANT-BEAR, in zoology; a genus of quadrupeds, belonging to the order of bruta; the characters of which are theſe: There are no teeth in the mouth; the tongue is long and cylindrical: the head terminates in a long ſnout or muzzle; and the body is covered with pretty long hair. There are four ſpecies, viz. Plate CLXXXV.

1. The didactyla, or little ant-eater, hath a conic noſe bending a little down; ears ſmall, and hid in the fur; two hooked claws on the fore-feet, the exterior being much the largeſt; four on the hind-feet; the head, body, limbs, and upper part and ſides of the tail, covered with long ſoft ſilky hair, or rather wool, of a yellowiſh brown colour: from the noſe to the tail it meaſures ſeven inches and an half; the tail eight and an half; the laſt four inches of which on the under ſide are naked. It is thick at the baſe, and tapers to a point. In inhabits Guinea, climbs trees in queſt of a ſpecies of ants which build their neſts among the branches: has a prehenſible power with its tail.

2. The tridactyla, tamandua-guaca, or tamanoir, has three toes on the fore-feet, five on the hind-feet, and long hair on the tail. This animal is about four feet long, and the head and ſnout about 15 inches: it is a native of the Eaſt Indies, and feeds on ants, &c. in the ſame manner as the former.

3. The jubata, or great ant-eater, hath a long ſlender noſe, ſmall black eyes; ſhort round ears; a ſlender tongue two feet and an half long, which lies double in the mouth; the legs ſlender; four toes on the fore-feet, five on the hind-feet; the two middle claws on the fore-feet very large, ſtrong, and hooked; the hair on the upper part of the body is half a foot long, black mixed with grey; the fore-legs are whitiſh, marked above the feet with a black ſpot; the tail is clothed with very coarſe black hair a foot long: the length from the noſe to the tail about four feet; the tail, two feet and an half.

4. The tetradactyla, or middle ant-eater, has four toes on the fore-feet, and five on the hind, with a tail naked at the extremity; the length from the noſe to the tail is one foot ſeven inches, and the tail ten inches.

Theſe animals have many properties in common with each other, both in their ſtructure and manners. They all feed upon ants, and plunge their tongues into honey and other liquid or viſcid ſubſtances. They readily pick up crumbs of bread, or ſmall morſels of fleſh. They are eaſily tamed, and can ſubſiſt for a long time without food. They never ſwallow all the liquor which they take for drink; for a part of it falls back through their noſtrils. They run ſo ſlowly that a man may eaſily overtake them in an open field. Their fleſh, though its taſte be very diſagreeable, is eaten by the ſavages.—At a diſtance the great ant-eater has the appearance of a fox; and for this reaſon ſome travellers have given him the name of the *American fox*. He has ſtrength ſufficient to defend himſelf from a large dog, or even from the jaquar or braſilian cat. When attacked, he at firſt fights on end, and, like the bear, annoys his enemy with the claws of his fore-feet, which are very terrible weapons. He then lies down on his back, and uſes all the four feet; in which ſituation he is almoſt invincible; and continues the combat to the laſt extremity. Even when he kills his enemy, he quits him not for a long time after. He is enabled to reſiſt better than moſt other animals; becauſe he is covered with long buſhy hair; his ſkin is remarkably thick; his fleſh has little ſenſation; and his principle of life is very tenacious.

Myrmidons ‖ Myrrh.

MYRMIDONS, MYRMIDONES, in antiquity; a people of Theſſaly, fabled to have aroſe from ants or piſmires, upon a prayer put up for that purpoſe by king Æacus to Jupiter, after his kingdom had been diſpeopled by a ſevere peſtilence.—In Homer and Virgil, the Myrmidons are Achilles's ſoldiers.

MYROBALANS, a kind of medicinal fruit brought from the Indies, of which there are five kinds. 1. The citrine, of a yellowiſh red colour, hard, oblong, and the ſize of an olive. 2. The black, or Indian myrobalan, of the bigneſs of an acorn, wrinkled, and without a ſtone. 3. Chebulic myrobalans, which are of the ſize of a date, pointed at the end, and of a yellowiſh brown. 4. Emblic, which are round, rough, the ſize of a gall, and of a dark brown. 5. Balleric, which are hard, round, of the ſize of an ordinary prune, leſs angular than the reſt, and yellow. They are all ſlightly purgative and aſtringent. The word comes from the Greek μυρον, "ointment," and βαλανος, "acorn;" as being in the form of acorns, and uſed in medicine.

MYRON, an excellent Grecian ſtatuary, flouriſhed 442 B. C. The cow he repreſented in braſs was an admirable piece of workmanſhip, and was the occaſion of many fine epigrams in Greek.

MYRRH, in the materia medica, a concrete, gummy, reſinous juice, brought from the Eaſt Indies in globes or drops, of various colours and magnitudes. The beſt ſort is of a brown reddiſh or yellow colour, ſomewhat tranſparent; of a lightly pungent bitter taſte, with an aromatic flavour, though not ſufficient to prevent its proving nauſeous to the palate; and a ſtrong diſagreeable ſmell. The medical effects of this aromatic bitter are, to warm and ſtrengthen the viſcera, and diſſolve thick tenacious juices: it frequently occaſions a mild diaphoreſis, and promotes the fluid ſecretions in general. Hence it proves ſerviceable in languid caſes; diſeaſes ariſing from a ſimple inactivity; thoſe female diſorders which proceed from a cold, mucous, ſluggiſh indiſpoſition of the humours; ſuppreſſions of the uterine diſcharges; cachectic diſorders, where the lungs and thorax are oppreſſed by viſcid phlegm. Myrrh is likewiſe ſuppoſed in a peculiar manner to reſiſt putrefaction in all parts of the body; and in this light ſtands recommended in malignant, putrid, and peſtilential fevers, and in the ſmall-pox;

pox; in which laſt it is ſaid to accelerate the eruption.—Rectified ſpirit extracts the fine aromatic flavour and bitterneſs of this drug, and does not elevate any thing of either in evaporation: the gummy ſubſtance left by this menſtruum has a diſagreeable taſte, with ſcarce any thing of the peculiar flavour of the myrrh; and diſſolves in water, excepting ſome impurities which remain. In diſtillation with water, a conſiderable quantity of a ponderous eſſential oil ariſes, reſembling in flavour the original drug.

MYRTIFORM, in anatomy, an appellation given to ſeveral parts, from their reſembling myrtle-berries.

MYRTLE, in botany. See MYRTUS.

MYRTUS, in botany, the MYRTLE; a genus of the monogynia order, belonging to the icoſandria claſs of plants. The moſt remarkable ſpecies are, 1. The communis, or common myrtle-tree, riſes with a ſhrubby, upright, firm ſtem, branching numerouſly all around into a cloſe full head, riſing eight or ten feet high; very cloſely garniſhed with oval-lanceolate, entire, moſtly oppoſite leaves, from half an inch to an inch and a half long, and one broad, on ſhort footſtalks; and numerous, ſmall, pale flowers from the axillas, ſingly on each footſtalk, having diphyllous involucrums; each flower ſucceeded by a ſmall, oval, dark-purple berry.

The moſt material varieties are, Broad-leaved Roman myrtle, with oval, ſhining, green leaves, an inch and an half long, and one broad; and is remarkably floriferous. Gold-ſtriped broad-leaved Roman myrtle. Broad-leaved Dutch myrtle, with ſpear-ſhaped, ſharp-pointed, dark-green leaves, an inch long, and about three quarters of one broad. Double-flowered Dutch myrtle. Broad-leaved Jews myrtle, having the leaves placed by threes at each joint; by which particular circumſtance this ſpecies is in univerſal eſtimation among the Jews in their religious ceremonies, particularly in decorating their tabernacles; and for which purpoſe many gardeners about London cultivate this variety with particular care, to ſell to the above people, who are often obliged to purchaſe it at the rate of ſixpence or a ſhilling for a ſmall branch: for the true ſort, having the leaves exactly by threes, is very ſcarce, and is a curioſity; but by care in its propagation, taking only the perfectly ternate-leaved ſhoots for cuttings, it may be increaſed faſt enough; and is worth the attention of the curious, and particularly thoſe who raiſe myrtles for the London markets. Orange-leaved Spaniſh myrtle, with oval ſpear-ſhaped leaves, an inch and a half long or more, and one broad, in cluſters round the branches, and reſemble the ſhape and colour of orange-tree leaves. Gold-ſtriped-leaved orange myrtle. Common upright Italian myrtle, with its branches and leaves growing more erect, the leaves oval, lanceolate-ſhaped, acute-pointed, and near an inch long, and half a one broad. Silver-ſtriped upright Italian myrtle. White-berried upright Italian myrtle. Portugal acute-leaved myrtle, with ſpear-ſhaped, oval, acute-pointed leaves, about an inch long. Box-leaved myrtle, with weak branches, ſmall, oval, obtuſe, lucid-green, cloſely-placed leaves. Striped box-leaved myrtle. Roſemary leaved myrtle, hath erect branches, ſmall, narrow, lanceolate, acute-pointed, ſhining, green, very fragrant leaves. Silver-ſtriped roſemary-leaved myrtle. Thyme-leaved myrtle, with very ſmall cloſely-placed leaves. Nutmeg-myrtle, with erect branches and leaves; the leaves oval, acute-pointed, and finely ſcented like a nutmeg. Broad-leaved nutmeg-myrtle. Silver-ſtriped leaved ditto. Criſtated or cock's-comb myrtle, frequently called *bird's-neſt myrtle*, hath narrow, ſharp-pointed leaves, criſtated at intervals.

Theſe are the principal varieties of the *myrtus communis;* but of which ſorts there are ſeveral intermediate varieties of leſs note; and more may ſtill be obtained from ſeed, though the plants are rarely raiſed from ſeed in this country, but moſtly by ſlips and cuttings.

They are all beautiful ever-green ſhrubs of exceeding fragrance; exotics originally of the ſouthern parts of Europe, and of Aſia and Africa, and conſequently in this country require ſhelter of a green-houſe in winter: all of which, though rather of the ſmall-leaved kind, have their foliage cloſely placed, and remain all the year, and are very floriferous in ſummer; and when there is a collection of the different ſorts, they afford an agreeable ſource of variety with each other. They therefore claim univerſal eſteem as principal green-houſe plants, eſpecially as they are all ſo eaſily raiſed from cuttings, and of ſuch eaſy culture as to be attainable in every garden, where there is any ſort of green-houſe, or garden-frames furniſhed with glaſſes for protecting them in winter from froſt: but ſome of the broad-leaved ſorts are ſo hardy as to ſucceed in the full ground, againſt a ſouth wall and other warm expoſures, all the year, by only allowing them ſhelter of mats occaſionally in ſevere froſty weather: ſo that a few of theſe ſorts may alſo be exhibited in a warm ſituation in the ſhrubbery: obſerving, however, all the ſorts are principally to be conſidered as green-houſe plants, and a due portion of them muſt always remain in pots to move to that department in winter.

Stove-kinds.—There are ſeveral ſpecies of the ſtove-temperature, as being natives of the Indies: but there are not more than the four following ſorts commonly met with in the Britiſh gardens, all of which are beautiful ever-greens, with larger leaves than the *myrtus communis;* and are moſtly ſtrong aromatics.

2. The zelanica, or Ceylon white-berried myrtle, hath a ſhrubby upright ſtem, branching erectly ſix or eight feet high; oval, ſhining-green, oppoſite, very odoriferous leaves, on ſhort footſtalks; and all the branches terminated by pedunculi, each ſuſtaining many flowers; ſucceeded by ſnowy-white berries, but rarely in Britain.

3. The pimenta, pimento, or Jamaica all-ſpice-tree, riſes with an upright tree-ſtem, branching regularly 20 or 30 feet high, having a ſmooth brown bark; large, oblong-oval, ſtiff, ſhining, very odoriferous leaves, like thoſe of bay, placed alternate; and at the ſides and termination of the branches large looſe bunches of greeniſh flowers; ſucceeded by round, duſky, hard, ſpicey fruit, called *all-ſpice*, or *Jamaica-pepper.*—This ſpecies is an excellent aromatic; its leaves are remarkably fine-ſcented; and its fruit is that valuable ſpice, Jamaica pepper, or all-ſpice, ſo called, becauſe it is ſuppoſed to partake of the odour and taſte of moſt other ſpices. The tree grows in great abundance in the iſland of Jamaica, where its fruit is made a conſiderable branch of trade. It is generally gathered a little

Myrtus. before it acquires full growth, and dried in the ſun 10 or 12 days; and is then packed up ready for exportation to Europe.

4. The diœca, or diœcious American myrtle, riſes with an upright tree-ſtem, branching many feet high; oblong, thick, oppoſite, odoriferous leaves; and at the axillas and ends of the branches pedunculi dividing into trichotomous panicles of diœcious flowers; ſucceeded by ſmall, globular, ſpicey berries. Every part of the tree is a ſtrong aromatic.

5. The braſiliana, or Braſilian inodorus myrtle, riſes with a branching ſtem, having a whitiſh bark: broad, oval, ſhining, oppoſite, inodorous or ſcentleſs leaves, and naked pedunculi, ſuſtaining ſolitary flowers, with ciliated petals; ſucceeded by large oval fruit.

All theſe five ſpecies of myrtus are exotics of the ſhrub and tree kind; though in this country, as being confined in pots, the largeſt of them aſſume only the growth of moderate ſhrubs. The firſt ſpecies, common myrtle, is conſiderably the moſt noted ſpecies of this genus in this country; where in moſt of our green-houſe collections one or other of the varieties is found in tolerable plenty; but all the varieties of it highly merit notice. The other four ſpecies are rare in Britain: they, however, are retained in many curious gardens, in the ſtove-collection; more particularly the pimento, which is a very beautiful odoriferous evergreen, and exhibits a fine variety in the ſtove at all ſeaſons. In ſhort, all the ſpecies, both green-houſe and ſtove-kinds, have a pretty effect as ever-greens; and ſome of the ſorts flower very ornamentally, particularly of the common myrtle.

With reſpect to flowering, all the varieties of the *myrtus communis* flower here in July and Auguſt, moſt of which are very floriferous: the broad-leaved Roman kind, in particular, is often covered with flowers, which in ſome of the ſorts are ſucceeded here by berries ripening in winter. Some of the ſtove kinds alſo flower here, but are rarely ſucceeded by fruit in England.

The flowers, however, of moſt of the ſorts are ſmall, but numerous; and are all formed each of five oval petals, and many ſtamina.

As all the ſpecies require occaſional ſhelter here, they muſt be kept always in pots, for moving to the proper places of ſhelter, according to their nature; the *myrtus communis* and varieties to the green-houſe in winter; the others to the ſtove, to remain all the year: therefore let all the ſorts be potted in light rich earth, and, as they advance in growth, ſhift them into larger pots, managing the myrtles as other green-houſe ſhrubs, and the ſtove-kinds as other woody exotics of the ſtove.

But, as we before obſerved, the broad-leaved *myrtus communis*, being hardier than the ſmaller-leaved kinds, ſome of them may alſo be turned out into the full ground in a warm ſituation againſt a wall, &c. allowing them ſhelter of mats in froſty weather, and mulch the ground over their roots: they will frequently ſucceed tolerably, and effect a good variety in ſuch places. They may all be propagated by ſlips, cuttings, or layers.

The leaves and flowers of common upright myrtle have an aſtringent quality, and are uſed for cleanſing the ſkin, and ſtrengthening the fibres. From the flowers and young tops is drawn a diſtilled water that is deterſive, aſtringent, coſmetic, and uſed in gargles. A decoction of the flowers and leaves is applied in fomentations. The berries have a binding deterſive quality; and the chemical oil obtained from them is excellent for the hair, and uſed in pomatums and moſt other external beautifiers of the face and ſkin. As an internal medicine, theſe berries have little or no merit.

Myſia, Myſtery. MYSIA, (anc. geog.), a country of the Hither Aſia, which Strabo makes two-fold; the one called *Olympena*, near mount Olympus, whence its name; the other near the river Caicus and Pergamene, as far as Teuthrania, and down to the mouth of the Caicus; a part of which was afterwards called *Æolis*, from the Eolians, (Mela, Pliny); by which means this Myſia was greatly contracted in its limits.—There were alſo two other Myſias, called *Abrettene* and *Morene*; which ſee. Strabo mentions a ſmall diſtrict, called *Myſia Combuſta*, famous for generous wines; which, whether to be allotted to *Myſia* or *Lydia*, he is doubtful: it was in length 500 ſtadia, in breadth 400: and he obſerves, that it is a matter of difficulty to ſettle the limits of the Bithynians, Myſians, Phrygians, Mygdonians, and Trojans, being ſo intermixed and blended; which gave riſe to a proverb, denoting the difficulty of diſtinguiſhing things, though really diſtinct. *Myſi*, or *Myſii*, the people, were held in the utmoſt contempt; ſo that *Myſorum ultimus* denotes a perſon highly deſpicable, (Cicero): and becauſe the being made a property of is generally the conſequence of contempt, this gave riſe to another proverb, Μυσων λεια, (Ariſtotle). The name *Myſe* is ſaid to denote the beech-tree, which grows plentifully about Olympus; and hence the country took its name.

MYSTERY, ſomething ſecret or concealed, impoſſible or difficult to comprehend.

All religions, true or falſe, have their myſteries. The pagan religion was remarkably full of them. Ovid reckons it a great crime to divulge the myſtic rites of Ceres and Juno. The eleuſinia, or ſacred rites of Ceres, ſolemniſed at Eleuſis, were called, by way of eminence, *the myſteries*; and ſo ſuperſtitiouſly careful were they to conceal theſe ſacred rites, that if any perſon divulged any part of them, he was thought to have called down ſome divine judgment on his head, and it was accounted unſafe to abide under the ſame roof with him; and Horace declares, that he would not put to ſea in the ſame ſhip with one who revealed the myſteries of Ceres. The pagan myſteries, it is true, were generally myſteries of iniquity, and concealed only becauſe their being publiſhed would have rendered their religion ridiculous and odious. Thus the ſacred writings often ſpeak of the infamous myſteries of the pagan deities, in which the moſt ſhameful crimes were committed under the ſpecious veil of religion.

The whole religion of the Egyptians was myſterious from the beginning to the end, and both their doctrine and worſhip wrapped up in ſymbols and hieroglyphics.

The religion of the Jews is ſuppoſed to be full of myſteries. The whole nation, according to St Auguſtin, was a myſtery, as it repreſented or was a type of the people of Chriſt, and the Chriſtian religion. Whatever was commanded or forbidden them was figurative;

gurative; and their facrifices, priefthood, &c. included myfteries. The prophecies concerning Jefus Chrift in the Jewifh books, are likewife figurative and myfterious.

The Chriftian religion has alfo its myfteries: but in the fcripture-language the word *myftery* is ufed with fome latitude, and denotes whatever is not to be known without a divine revelation, and all the fecret things which God has difcovered by his minifters the prophets, by Jefus Chrift and his apoftles. The myfteries of the Chriftian church are, The incarnation of the Word; the hypoftatical union of the divine and human natures; the miraculous birth, death, and refurrection of the Son of God; the doctrine of the Trinity, &c.

St Paul often fpeaks of the myfteries of the Chriftian religion; as the myftery of the gofpel, the myftery of the crofs of Chrift, the myftery which was kept fecret fince the world began: and he calls the preachers of the gofpel, the ftewards of the myfteries of God.

MYSTICAL, fomething myfterious or allegorical. Some of the commentators on the facred writings, befides a literal, find alfo a myftical meaning. The fenfe of fcripture, fay they, is either that immediately fignified by the words and expreffions in the common ufe of language; or it is mediate, fublime, typical, and myftical. The literal fenfe they again divide into proper literal, which is contained in the words taken fimply and properly; and metaphorical literal, where the words are to be taken in a figurative and metaphorical fenfe. The myftical fenfe of fcripture they divide into three kinds: the firft correfponding to faith, and called *allegorical;* the fecond to hope, called *anagogical;* and the third to charity, called the *tropological fenfe.* And fometimes they take the fame word in fcripture in all the four fenfes: thus the word *Jerufalem,* literally fignifies the capital of Judæa; allegorically, the church militant; tropologically, a believer; and anagogically, heaven. So that paffage in Genefis, *let there be light, and there was light,* literally fignifies corporeal light; by an allegory, the Meffiah; in the tropological fenfe, grace; and anagogically, beatitude, or the light of glory.

MYSTICS, a religious fect, diftinguifhed by their profeffing a pure, fublime, and perfect devotion, with an entire difinterefted love of God, free from all felfifh confiderations, and by their afpiring to a ftate of paffive contemplation.

MYTHOLOGY. The word *mythology* is a Greek compound, that fignifies a *difcourfe on fables;* and comprehends, in a collective fenfe, all the fabulous and poetic hiftory of pagan antiquity. It follows therefore, that this fcience teaches the hiftory of the gods, demi-gods, and fabulous heroes of antiquity; the theology of the pagans, the principles of their religion, their myfteries, metamorphofes, oracles, &c. By this definition, it appears fufficiently what are the objects of which we are to treat in this article.

If we well confider the matter, we fhall find, that there were, in pagan antiquity, three different religions. *Firft,* That of the philofophers, who treated metaphyfically of the nature, the attributes, and of the works of the Supreme Being. They endeavoured to difcover the true God, and the manner in which he ought to be worfhipped. It is not wonderful, that thefe men of exalted genius fhould in fome degree ridicule, in their works, the two other pofitive religions, and thofe gods on whom they were founded; at the fame time that they outwardly profeffed the eftablifhed religion, in order to preferve the peace of fociety, and to avoid the perfecutions of the legiflature, and the infults of the populace. For in fact, was it poffible for them to believe the pagan fables? Muft they not forefee, that their religion would one day give place to another, while their own works would pafs with their names to the lateft pofterity? And could they fuffer the thought, that their reputation would be tarnifhed in the eyes of that pofterity, by having it imagined they believed fuch idle tales as were broached by the priefts of their times? Could Plato, Socrates, Seneca, and Cicero, be unconcerned for their fame among future generations and future philofophers? And what fhould we at this day have faid of thofe great men, had they been fo political, or hypocritical, as to have entirely concealed their fentiments with regard to thefe matters?

The fecond religion was that of paganifm, which was the eftablifhed religion of all the ancient nations except the Jews. This was the doctrine that was taught by the priefts, and protected by the fovereigns. Its dogmas were demonftratively falfe, but not always fo abfurd as may at firft appear; efpecially if we annex to the divinities, and to the religious ceremonies of the pagans, a fenfe that is frequently myftic, and always allegoric; if we remember, that the firft heathens deified thofe great men to whom the reft of mankind were indebted for any fignal benefits, as Jupiter, Apollo, Ceres, Bacchus, Hercules, Æfculapius, &c. in order to induce others, as well of the prefent as future ages, to reverence and to imitate them. Would not an ancient pagan, if he were to return upon the earth, have fpecious arguments, at leaft, to fupport his religion, when he faw weak mortals beatify or canonize, merely by their own authority, other weak mortals (frequently mere pedants), and place them in heaven, without the permiffion or approbation of the Supreme Being? Happy is it for mankind, when at different times fagacious pontiffs purge the kalendar, and the brains of the people, from a herd of pretended faints, and prevent them, at leaft after their death, from doing injury to fociety, by interrupting the induftry of the laborious inhabitants with keeping their feftivals.

The third religion was idolatry, or the religion of the populace. For the common people, born to be deceived in every thing, confounding in their imaginations the ftatues of the gods, the idols of their divinities, the emblems of their virtues and of religious worfhip, with the gods, divinities, virtues, and worfhip themfelves, adored thefe images, and proceeded to extravagancies the moft ridiculous, and frequently moft criminal, in their ceremonies, feafts, libations, facrifices, &c. It is to be feared, that, as long as there are upon the earth men of our limited capacities, this triple religion will conftantly fubfift under different forms; and we are much deceived, if it may not be found under the empire of Chriftianity itfelf, notwithftanding the purity of its doctrine. It will be eafily conceived, that it is not of the religion of philofophers, nor that of the populace, of which we are to treat in this article of Mythology: but of that which

Mythology. fubfifted under the authority of the magiftracy and the priefthood, and confequently of paganifm in general.

As far as we are able to judge by all the ancient authors we have read, the pagans adored the fovereign Lord of the univerfe under the name of *Fate* or *Deftiny*, which we muft not confound with Fortune, who was regarded as a fubaltern divinity. Jupiter himfelf, all the gods, every animated being, the heavens, the earth, the whole frame of nature, was fubfervient to Deftiny, and nothing could reverfe its decrees. This divinity was fo highly adorable, as to be above all rank; and was regarded as too fupreme to be reprefented under any fenfible image or ftatue, or to have any temple erected for its worfhip. We do not remember to have read, that ever any facrifice was offered to this Deftiny, or that any temple or city was ever dedicated to its name. We are almoft inclined to think, that the pagans were fenfible, that the temple and the worfhip of the God of gods ought to be in the heart of man. Mention is made, indeed, of a temple that was dedicated to the Unknown God; but we are ignorant whether or not Deftiny were thereby meant. We muft not confound this Deftiny, moreover, with the goddefs of chance, of which there are fome antique ftatues that reprefent her in a recumbent pofture, and playing with little bones; for this was nothing more than an invention of fome ftatuary.

After this general and philofophical idea of the Supreme Being, comes the pofitive religion of the pagans. This was entirely founded on fable, which took its rife either from ancient traditions, or hiftorical events, altered or augmented by the imaginations of the poets, by fuperftition, or by the credulity of the people; or elfe it confifted of allegoric or moral fictions. A crowd of writers, and among the reft *Noel le Comte*, (Natalis Comes), the abbots Bannier and Pluche, &c. have made many refearches into the origin of fable: and they think they have difcovered its fource, 1. In the vanity of mankind; 2. In the want of letters and characters; 3. In the delufive eloquence of orators; 4. In the relations of travellers; 5. In the fictions of poets, painters, ftatuaries, and dramatic writers; 6. In the diverfity and uniformity of names; 7. In the ignorance of true philofophy; 8. in the foundation of colonies, and the invention of arts; 9. In the defire of having gods for our anceftors; 10. In the imperfect or falfe interpretation of the holy fcriptures; 11. In the ignorance of ancient hiftory; 12. In a like ignorance of chronology; 13. In that of foreign languages; 14. In the tranflation of the religion of the Egyptians and Phœnicians into Greece; 15. In the ignorance of geography; and, 16. In the belief which the firft people had of the intercourfe of gods with men. It is certain, that all thefe matters taken together are fufficient to produce many thoufands of fables; are more than fufficient to enable us to deceive ourfelves and others, and to give rife to infinite reveries. But we fhould take care how we draw from thefe fources demonftrations that might be ufed, by infidels, as arguments to overthrow the hiftory of the Jews; a people the moft ftupid, moft credulous, and oftentatious of all others. In the mean time, the pagan philofophers themfelves afferted, that it was a god who invented the fable: fo much they were convinced of its ingenuity, and of its ftrong tendency to inftruct mankind in their duty.

Mythology therefore, when properly treated, begins with making learned refearches into the real origin of fable, of paganifm, and of that idolatry which was its confequence. It recurs for this purpofe even to the beginning of the world: and after finding that Laban, the father in-law of the patriarch Jacob, was a maker of idols, and that he had his little images, or houfehold gods, which he formed of baked earth, and which fhews that idolatry exifted in the greateft antiquity; it then explains cofmogony, and theogony, or the belief that the firft inhabitants of the earth entertained of the creation of the univerfe, and what the pagan theology taught of the genealogy of their falfe gods. It begins with the tradition of the Chaldeans, a people fo ancient, that Nimrod was their firft king; but at the fame time fo credulous and fuperftitious, that we may regard them as the authors of all thofe fables, and the propagators of all thofe vifions, that have fince blinded human reafon. According to this tradition, a monfter named *Oannes*, or *Oes*, half fifh and half man, fprang from the fea, before the chaos was completely difperfed, and gave laws to the Chaldeans. A woman called *Omorka*, reigned over all the earth. *Bel* cut her in two, and made of one moiety the heavens, and of the other the earth. They likewife invented the two primitive beings; of which the good one, who was named *Orafmafdes*, had the direction of heaven; and the other, called *Arimanius*, that of hell.

The fcience of mythology then teaches the theogony of the Phœnicians; concerning whom it draws great lights from Sanchoniathon, a prieft of Beryte, who lived before the Trojan wars, more than 400 years before Hefiod and Homer, and of whom Eufebius has preferved confiderable fragments. From thence it paffes to the theogony of the Egyptians; of whom *Thot* or *Thaut*, the founder of that nation, was likewife, they fay, their firft hiftorian; that Sanchoniathon even copied from him; and of whom we find many relations in the Greek hiftorians, efpecially in Herodotus, Diodorus Siculus, and in Eufebius of Cæfarea. It then examines the theogony of the Atlantides, who dwelt on the weftern part of Africa, and of whom Diodorus alone has preferved any account. From thence it proceeds to the theogony of the Greeks, which is far better known to us, as we find accounts of it, more or lefs particular, in numberlefs Greek and Latin writers. This theogony had the fame foundation as that of the Romans; the latter having only extended it, by addding to the Greek divinities certain gods or demigods, formed of their heroes, and certain fymbolic and allegoric divinities, which mythology explains at the fame time: and it is on this occafion that it enters into a particular explication of the cofmogony and theogony of Ovid; whofe book of metamorphofes contains as copious defcriptions as we could defire of the fables of the ancients: what was their belief concerning the habitations of the bleffed after their death, or of the Elyfian fields; as well as of their hell or Tartarus; of the dog Cerberus; of the ferryman Charon; of the furies; of the four rivers, Cocytus, Lethe, Phlegethon, and Styx, which water the Tartarian regions, &c.

Mythologifts then continue their refearches into the time, the epoch, and place, of the real origin of paganifm and idolatry; and they prove that the pagans began

 began by adoring the heavenly bodies, the ftars and planets. They next examine into the progrefs of idolatry: what were the temples of the pagans, their altars, their inclofures, their facred groves, their afylums, the idols and ftatues of their deities; in what manner they were reprefented; what were their facrifices, the victims that were offered; what the days of penitence and fupplication, the feafts or the gods of lectifternia, their invocations or incantations and exorcifms, the religious ceremonies obferved at laying the foundations of cities, &c.

Divination, or the prediction of future events, a weaknefs that has at all times poffeffed the human mind, forms alfo an important article of pagan theology. It is therefore in this place that mythology confiders the nature of oracles, and in what manner thefe oracles gave their anfwers; the ceremonies that were obferved in confulting them; the frantic emotions of the prieftefs Pythia on her tripod, and thofe of other priefts. See DIVINATION and ORACLES.—It then endeavours to inveftigate the hiftory of the Sibyls, and of their prophecies. See SIBYLS.—It next paffes to the examen of the nature of auguries, aufpices, harufpices, prodigies, &c.; of expiations and ablutions; of the magic and aftrology of the ancients, &c. See AUGURY, &c.—It then proceeds to the examination of the nature of the pagan divinities themfelves.

The celebrated treatife of Cicero *De natura Deorum*, will here furnifh great lights: but modern authors who have treated on thefe matters, have not been contented with this alone: they have, fo to fay, extracted the effence of all antiquity, of which they have formed fyftems; but unluckily thefe fcarce ever agree with each other. As philofophers, it is of very little importance for us to know what was the nature of thefe gods, feeing we know that they were merely fabulous: but as hiftorians and antiquaries, it concerns us to know what was the nature that was attributed to them in general; and, in particular, what were the origin, genealogy, rank, functions, authority, and operations, that were attributed to each divinity; and it is on thefe matters that we have ftill fome remarks to make.

The gods of the ancient Greeks and Romans were all either *Dii majorum gentium*, or *Dii minorum gentium;* that is, of the firft or fecond order. The former were alfo called *confentes*, *magni confultores*, &c. According to Ennius, they were 12 in number, and are included in thefe verfes:

Juno, Vefta, Minerva, Ceres, Diana, Venus, Mars,
Mercurius, Jovis, Neptunus, Vulcanus, Apollo.

To thefe were added eight others, under the title of *Selecti*, which were Sol, Luna, Tellus, Genius, Janus, Saturnus, Liber, and Pluto. The fecond order, or *minorum gentium*, were called *Adfcriptitii*, *Medioximi*, *Minufcularii*, *Putatitii*, *Indigetes*, *Semones*, *&c.* the principal of which were Æfculapius, Bacchus, Caftor, Fauna, Hercules, the Lares or Penates, Pollux, Quirinus. See thefe under their feveral articles, &c.

According to the fecond divifion, all their divinities were claffed into, 1. Celeftial gods; 2. Terreftrial gods; 3. Sea gods; and, 4. The infernal deities, or *inferi*. The celeftial gods were Jupiter, Juno, Apollo, Aurora, Cupid, Cybele, the Graces, Hebe, Iris, Luna, Mars, Mercury, Minerva, Nemefis, Saturn, Themis, Venus, &c. The terreftrial gods were Æolus, Aftræa, Ceres, Diana, the Fauni, Feronia, Flora, Janus, Momus, the Mufes, Pales, Pan, Pomona, Priapus, the Satyrs, Silenus, the god Terminus, Vefta or Rhea, Vulcan, &c. The fea-gods were Neptune, Amphitrite, Thetis, Canopus, Glaucus, Ino, the Nereids, Nereus, Oceanus, Palæmon, Triton, &c. The infernal gods were Pluto, Proferpine, Charon, Minos, Æacus, Rhadamanthus, the Furies, Death, Night, the Fates, Plutus, &c. See thefe articles.

The third divifion ranged the divinities according as they prefided, 1. Over the pregnancy of women, (*Prægnantium;*) 2. At parturitions (*Parturientium;*) 3. At births, (*Nafcentium;*) 4. At adulteries; 5. At marriages: to which they added, 7. Dii morales, or moral gods; and, 7. Funeral gods. The gods of pregnancy were Pilumnus, Intercidona, and Deverra: the gods of parturition, Juno, Lucina, Diana, Egerio, Profa, Poftverta, Menagenata, Latona, the gods that were called *Nixi*, or of *labour*, &c. The gods of birth were Janus, Opis, Nafcion, Cunina, Carmenta, Vaginianus, Levana, Rumia, Potina, Educa, Offilago, Carnea, Nundina, Statilinus, Fabulinus, Paventia, &c. The gods of adultery were Juventus, Agenoria, Strenua, Stimula, Horta, Quies, Murcia, Adeona, Abeona, Voluptas, Orbona, Pellonia, Numeria, Camoena, Sentia, Angerona, Heres, Martea, Laverna, the god Averruncus, Confus, Catius, Volumnus and Volumna, Honorius, Aius Locutius, &c. The nuptial gods were Diana, Domiduca, Domitius, Hymenæus or Hymen, Jugatinus, Jupiter perfectus, Juno perfecta, Juno cinxia, Juno unxia, Lucina, Manturna, Mutinus, Dea Mater prima, Suada, Thalaffius, Venus, &c. The moral gods were called *Virtus*, *Honor*, *Fides*, *Spes*, *Juftitia*, *Pietas*, *Mifericordia*, *Clementia*, *Pudicitia*, *Veritas*, *Mens*, *Concordia*, *Pax*, *Salus*, *Felicitas*, *Libertas*, *Pecunia*, *Rifus*, *Invidia*, *Contumelia*, *Impudentia*, *Calumnia*, *Fraus*, *Difcordia*, *Furor*, *Fama*, *Fortuna*, with all their epithets good or bad, *Febris*, *Pavor* and *Palor*, *Paupertas*, *Neceffitas*, *Tempeftas*, *Silentium*, *&c.* The funeral gods were Pluto, Libitina, Nænia, Death, the Fates, &c.

Hefiod indeed pretends, that all thefe gods derived their origin from chaos; but we have already pointed out more juft fources. It is almoft incredible to what a prodigious number the fuperftition and weaknefs of the Greeks and Romans multiplied thefe divinities; there have been 30,000 of them enumerated. It will not be expected that we fhould here attempt to defcribe them, nor will it be remarkable if we have forgotten to mention even fome of the firft rank: although, vaft as this company of gods is, mythology does not omit to trace the hiftory of the greateft part of them, as is taught by paganifm; and they who are defirous of particular information in thefe matters may confult with advantage the theogony of Hefiod, the catalogue of Apollodorus, the metamorphofes of Ovid, the fables of Hygina, Lylii Gregorii Gyraldi Syntagma de diis Gentilium, the mythology of Natalis Comes, the books of Gerard Voffius de idolatria Gentilium, Johannis Boccatii Genealogia deorum, the Pantheon of Pompey, the hiftory of heaven by Abbé Pluche, the hiftoric explanation of fables by Abbé Banier, and Bryant's Mythology.

 There were ftill many other diftinctions, of which the pagans made ufe to mark the rank, the functions, and nature of their feveral divinities. For example, the goddefs Vefta, or the mother of all the gods, was adored by all people in general. Mars, Bellona, Victoria, Fortunata, &c. affifted all parties. The topical gods, on the contrary, were adored in particular countries only; as Aftarte in Syria, Derceto and Semiramis among the Affyrians, Ifis and Ofiris by the Egyptians, Quirinus at Rome, &c. The title *Semones*, which was given to a certain clafs of divinities, was doubtlefs derived from *Semi-homines*, that is, *demi-men*; and fignified the fame as *femi-dii*, or *demi-gods*. Thefe were monarchs and illuftrious heroes, or thofe great men who were the founders of cities and nations, that were deified by way of apotheofis. Pythagoras had taught the Chaldeans the doctrine of tranfmigration; and that, after their death, thofe who were virtuous would be elevated to the rank of divinities. This doctrine was adopted by all the pagan world. The apotheofis, after they had erected temples and altars to the new gods, was celebrated with much folemnity. In the laft ceremony, an eagle was fixed on the catafalk, or funeral pile, on which was placed the image of the hero; and when the pile began to burn, the eagle was let loofe, who, mounting into the air with the flames, feemed to carry the foul of the departed hero up to heaven.

Mythology informs us alfo who thofe perfons were that antiquity regarded as the children of the gods, fuch as Thefeus, Hippolytus, Paris, &c. what the pagans believed with regard to the nature of their genii and demons, of their dryades, hamadryades, nymphs, tritons, firens, fauns, fylvans, centaurs, and other fubaltern divinities; and in this manner it explains all the fyftems of the pofitive religion of the Greeks and Romans. They who are defirous of extending their knowledge of paganifm ftill further, of knowing the dogmas of each particular people, what were their gods, and the various manners in which they were worfhipped, fuch as Apis, Ifis, Ofiris, &c. the adoration of crocodiles and onions, &c. among the Egyptians, muft ftudy the differents theogonies of thefe people; and notwithftanding all the informations which ancient and modern authors afford, this ftudy is yet boundlefs, and attended with many difficulties and uncertainties: though it appears demonftrative, that the origin of paganifm, and of idolatry in general, was derived from the Chaldeans, from whom the Egyptians drew that doctrine which they after tranfmitted to all other nations; and confequently that the primordial divinities were the fame, under different denominations, among all the idolatrous nations of the earth.

The nature of this work will not permit us to defcend to further particulars. But to give our readers an idea of the manner in which mythology treats its fubjects, and of the method that fhould be obferved in ftudying fable, or the hiftory of the gods of antiquity, we fhall here give, by way of example, a curfory defcription of Parnaffus and its inhabitants.

Parnaffus was a mountain of Phocis, that had two fummits, one of which was called *Tithoreus*, and the other *Hyampeus*. Others fay, that one of thefe hills was named *Helicon*, and the other *Cytheron*; and that it is an error to imagine, that Helicon was a mountain of Bœotia. However that be, this double hill was confecrated to Apollo and the mufes, who there held their ufual refidence. According to fable, there had been a remarkable combat on this hill, between Helicon and Çytheron. Whoever flept on Parnaffus, when he waked, became a poet. Apollo had there a temple. There alfo was the fountain Caftalia, into which Apollo had metamorphofed a nymph that he loved, and had given to its waters the power of making all who drank of them poets. At the foot of Parnaffus flowed the river Hippocrene, that had the fame virtue; and the fource of which was opened by a ftroke of the foot of the horfe Pegafus. This river nourifhed a great number of fwans, that were regarded as facred. Pegafus was a winged horfe, that belonged to Apollo, and grazed on the fummit of Parnaffus. He fprang from the blood of Medufa, when Perfeus cut off her head, which was placed among the ftars. Such was the delicious abode of Apollo, the fon of Jupiter and Latona, who was born, with his twin fifter Diana, in the ifland Delos. He killed the Cyclops, who forged the thunderbolts with which Jupiter had overthrown his fon Æfculapius; but for that prefumption he was forced to leave heaven, and became an inhabitant of the earth. He guarded the oxen of Admetus; he aided Neptune to build the walls of Troy, and Alcotheus in forming the labyrinth. He killed the dragon or ferpent Python. He invented mufic and phyfic; and was honoured as the god of poets and phyficians. He was reprefented as a young man without a beard, his head furrounded with rays, and bearing in his hand a bow, or a lyre. As the ancients denoted the fun by the name of *Apollo*, they fometimes reprefented him alfo as feated in a chariot, drawn by two white horfes, preceded by Aurora and the ftar Venus: Phaëton his fon, being defirous of conducting thefe horfes, was thrown into the fea. Apollo was alfo called *Phœbus*, *Titan*, and *Sol*. He is known to have had amours with Arfinoe, Corycia, Melœne, Cyrene, Mantho, Sinope, Calliope, and others; by whom he had Delphe, Naxe, Niletus, Arabe, Garamas, Sirus, Linus, Orpheus, and other children. He had peculiar honours paid him in the Pythian games at Delphos, and in the fecular games at Rome.

The mufes were the companions of Apollo in his rural abode. They were likewife called the *learned fifters*; as alfo the *Camœnion*, *Heliconian*, *Parnaffian*, *Aonian*, *Pierian*, *Pegafian*, *Aganippian*, *Thefpian*, *Libethrian*, and *Caftalian fifters*. They were the daughters of Jupiter and Mnemofyne, and were regarded as the goddeffes of fciences and arts in general. There were nine of thofe mufes; to whom they attributed; 1. To Clio, hiftory; 2. To Melpomene, tragedy; 3. To Thalia, comedy; 4. To Euterpe, flutes and otherp neumatic inftruments of mufic; 5. To Terpfichore, the harp and the dance; 6. To Erato, the lyre and the lute; 7. To Calliope, heroic verfe; 8. To Urania, aftronomy; and 9. To Polyhymnia, rhetoric and eloquence. The Graces alfo fometimes quitted Venus to pay their court to Apollo.

Such was the idea they entertained of Parnaffus and its inhabitants. There is no doubt but that, under thefe fabulous reprefentations, thefe fenfible images, were

were concealed allegoric and moral meanings; nor can it be denied but that their method of cultivating the arts and fciences, by this manner of expreffing their ideas, was as ingenious and pleafing as it is poffible to imagine. Every other fubject that paganifm embraced, it treated with the fame genius, and in a manner equally pleafing; and though that religion was altogether fallacious, yet we muft allow that it was extremely well calculated to promote the polite arts, by thofe refined, noble, graceful, brilliant images, by thofe charming fubjects, which it conftantly prefented, and which it ftill offers to the poet, painter, fculptor, and every other artift.

But this was not a power fufficiently ftrong to fecure paganifm againft that viciffitude, that decline and diffolution, which finally attends all the productions of this world. This religion, which had fubfifted near 5000 years, and almoft from the origin of the human race, gradually declined in proportion as the lights of Chriftianity and philofophy illumined the minds of mankind. For though the pagan religion, and the fables on which it is was founded, were pleafing and favourable to the polite arts, they were not however calculated to fatisfy the minds of philofophers, nor to promote the real good of mankind, by fecuring their temporal and eternal happinefs. It is even furprifing that fo great a genius as the emperor Julian fhould attempt to revive the embers of paganifm, which infenfibly declined, and had received a mortal blow at the beginning of the fourth century by the emperor Conftantine the great. Julian employed all the refources of his imagination, of his eloquence, of his power, and even of his own fatal example, to revive it; but in vain. The period of paganifm was arrived, and nothing could fave it from diftruction. The furious Theodofius, to whom bigotted priefts and hiftorians have affigned the name of *great*, totally overthrew it toward the clofe of the fame century, deftroyed thofe temples and altars which yet fubfifted, difperfed its colleges, and exterminated its priefts. From that dire epoch, nothing of paganifm has remained, except fome ruins difperfed in the remote parts of the earth, and among people wretched and almoft unknown; where this religion, once fo flourifhing and univerfal, is now degenerated into grofs and difguftful idolatry.

MYTULUS, the Muscle, in ichthyology; a genus of animals, belonging to the order of vermes teftacea. The animal is an afcidia: the fhell bivalve; often affixed to fome fubftance by a beard; the hinge without a tooth, marked by a longitudinal hollow line. The moft remarkable fpecies are, 1. The rugofus, or rugged mufcle, with a brittle fhell, very rugged, and in fhape very irregular; ufually oblong, and round at the ends. Its length is near an inch; the colour whitifh. It is always found lodged in limeftone; the outfide appears honey-combed; but the apertures are too fmall for the fhell to pafs through, without breaking into the cell they are lodged in. Multitudes are found in the fame ftone; but each has a feparate apartment, with a different external fpiracle. 2. The edulus, or edible mufcle, has a ftrong fhell, flightly incurvated on one fide, and angulated on the other. The end near the hinge is pointed; the other rounded. When the epidermis is taken off, it is of a deep blue colour. It is found in immenfe beds, both in deep water, and above low-water mark. The fineft mufcles are thofe called *Hambleton hookers*, from a village called *Humbleton* in that county. They are taken out of the fea, and placed in the river Wier, within reach of the tide, where they grow very fat and delicious. 3. The incurvatus, or crooked mufcle, is very crooked on one fide near the end; then greatly dilated, and covered with a thick rough epidermis. Within it has a violet tinge. It is found on the coaft of Anglefea, near Prieftholme; ufually an inch and an half long. 4. The pellucidus, or pellucid mufcle, hath a delicate tranfparent fhell, moft elegantly rayed lengthwife with purple and blue; like the former in fhape, but more oval; commonly fhorter than two inches. It is found in Anglefea, fometimes in oyfter-beds, fometimes in trowling over flutchy bottoms. 5. The umbilicatus, or umbilicated mufcle, is nearly of an oval form, the length fometimes five inches. It is a rare and new fpecies; fometimes dredged up off Prieftholme ifland, Anglefea; difcovered by the reverend Mr Hugh Davies. 6. The curtus, or fhort mufcle, with a fhort, ventricofe, obtufe fhell, of a dirty yellow colour, length about an inch. 7. The modiolus, or great mufcle, with a ftrong fhell, blunted at the upper end; one fide angulated near the middle; from thence dilating towards the end, which is rounded. It is the greateft of Britifh mufcles, being from fix to feven inches in length; it lies at great depths; often feizes the baits of ground-lines, and is taken up with the hooks. 8. The cygneus, or fwan mufcle, with a thin brittle fhell, very broad and convex, marked with concentric ftriæ; attenuated towards one end, dilated towards the other; decorticated about the hinge; the colour a dull green; the length fix inches, breadth three and a half; inhabits frefh waters. 9. The anatinus, or duck mufcle, hath a fhell more oblong and lefs convex than the laft; is very brittle and femitranfparent; the fpace round the hinges like the laft; the length about five inches, breadth two and a quarter; inhabits frefh waters. Crows feed on thefe mufcles, and alfo on different fhell-fifh. It is diverting to obferve, that when the fhell is too hard for their bills, they fly with it to a great height, drop the fhell on a rock, and pick out the meat when the fhell is fractured by the fall.

The common fea or edible mufcle has, from its being always found faftened to the rocks, been fuppofed by many wholly incapable of progreffive motion; but this is an erroneous opinion. It is a common practice in France, at fuch feafons of the year as do not afford fun enough to make falt, to throw the common fea-mufcles, which the fifhermen catch about the coafts, into the brine-pits. They have an opinion that this renders their flefh the more tender and delicate, as the rain which falls at thefe feafons makes the water of the pits much lefs falt than the common fea-water. The mufcles are on this occafion thrown carelefsly in, in feveral different parts of the pits; yet, at whatever diftances they have been thrown in, the fifhermen when they go to take them out, always find them in a clufter together; and as there is no current of water in thefe places, nor any other power of motion which can have brought the mufcles together, it feems

feems very evident that they muft voluntarily have marched from the places where they were at firft, to have met thus together. This progreffive motion is wholly performed by means of what we call the *tongue* of the mufcle, from its fhape; but, from its ufe in this cafe, appears rather to merit the name of a *leg*, or an *arm*, as by laying hold of any diftant fubftance, and then forcibly contracting itfelf again, it draws along the whole body of the fifh; the fame part, when it has moved the animal to a proper place, ferves alfo to fix it there, being the organ by which it fpins the threads which we call its *beard*, by which it is held to a rock, or to another mufcle. The motion of the mufcle, by means of this part, is juft the fame with that of a man laid flat on his belly, who would draw himfelf along by laying hold of any thing with one hand, and then drawing himfelf to it.

Mufcles are well known to have a power of faftening themfelves either to ftones, or to one another's fhells, in a very ftrong and firm manner; but the method of doing this was not well underftood till the obfervations of Mr Reamur explained it.

Every one who opens and examines a common mufcle, will find, that in the middle of the fifh there is placed a little blackifh or brownifh body refembling a tongue. This in large mufcles is near half an inch long, and a little more than a fixth of an inch in breadth, and is narrower at the origin than at the extremity: from the root of this tongue, or that part of it which is faftened to the body of the fifh, there are produced a great number of threads, which, when fixed to any folid fubftance, hold the mufcle firmly in its place: thefe threads are ufually from an inch to two inches in length, and in thicknefs from that of a hair to that of a hog's briftle. They iffue out of the fhell in that part where it naturally opens, and fix themfelves to any thing that lies in their way, to ftones, to fragments of fhells, or, which is the moft common cafe, to the fhells of other mufcles; whence it happens that there are ufually fuch large parcels of mufcles found together. Thefe threads are expanded on every fide, and are ufually very numerous, 150 having been found iffuing from one fhell: they ferve the office of fo many cables; and, each pulling in its proper direction, they keep the mufcle fixed againft any force that can be offered from whatever part it come. The filaments are well known to all who eat mufcles, who ever carefully feparate them under the name of the beard; and Mr Reaumur has found, that while the animal is living in the fea, if they are all torn away by any accident, the creature has a power of fubftituting others in their room: he found, that if a quantity of mufcles were detached from one another and put into a veffel of any kind, and in that plunged into the fea, they in a little time faftened themfelves both to the fides of the veffel, and to one another's fhells; the extremity of each thread feemed in this cafe to ferve in the manner of a hand to feize upon any thing that it would fix to, and the other part which was flenderer and fmaller to do the office of an arm in conducting it.

To know the manner of the mufcles performing this operation, this diligent obferver put fome mufcles into a veffel in his chamber, and covered them with fea-water; he there faw that they foon began to open their fhells, and each put forth that little body before defcribed by its refemblauce to a tongue, and at the root of which thefe threads grow; they extended and fhortened this part feveral times, and thruft it out every way, often giving it not lefs than two inches in length, and trying before, behind, and on every fide with it, what were the proper places to fix their threads at: at the end of thefe trials they let it remain fixed for fome time on the fpot which they chofe for that purpofe, and then drawing it back into the fhell with great quicknefs, it was eafy to fee that they were then faftened by one of thefe threads to the fpot where it had before touched and remained fixed for a few minutes; and in repeating this workmanfhip the threads are increafed in number one at every time, and being fixed in different places they fuftain the fifh at reft againft any common force.

The feveral threads were found to be very different from one another; the new formed ones being ever whiter, more gloffy, and more tranfparent than the others: and it appeared on a clofe examination, that it was not, as might have been moft naturally fuppofed, the office of the tongue to convey the old threads one by one to the new places where they were now to be fixed, but that thefe in reality were now become ufelefs; and that every thread we fee now formed, is a new one made at this time; and in fine, that nature has given to fome fea-fifhes, as well as to many land-infects, a power of fpinning thofe threads for their neceffary ufes; and that mufcles and the like fifh are under water, what caterpillars and fpiders are at land. To be well affured of this, however, Mr Reaumur cut off the beard or old threads of a mufcle as clofe as he could, without injuring the part; and the proof of the opinion of their fpinning new ones at pleafure was now brought to this eafy trial, whether thefe mufcles, fo deprived of their old ones, could fix themfelves as foon as others which were poffeffed of theirs, and could throw out their threads to as confiderable diftances. The experiment proved the truth of the conjecture; for thofe whofe beards or old threads were cut off, fixed themfelves as foon as thofe in which they were left, and fpread their threads to as great a diftance every way.

When the mechanifm of this manufacture was thus far underftood, it became a natural defire to inquire into the nature of the part by which it was performed: this has hitherto been mentioned under the name of the tongue, from its fhape; but it is truly the arm of the fifh; and whenever it happens to be loofened from its company, or fixed in a wrong place, it ferves the animal to drag its whole body fhell and all along, and to perform its feveral motions. It fixes itfelf to fome folid body; and then ftrongly contracting its length, the whole fifh muft neceffarily follow it, and be pulled toward the place where it is fixed. This is an ufe, however, that this part is fo rarely put to, that it is not properly to be efteemed a leg or an arm, for this; but, according to its more frequent employment, may much better be denominated the organ by which the threads are fpun.

Though this body is flat in the manner of a tongue for the greater part of its length, it is however rounded or cylindric about the bafe or infertion, and it is much fmaller there than in any other part: there are feveral

ſeveral muſcular ligaments faſtened to it about the root or baſe, which hold it firmly againſt the middle of the back of the ſhell; of theſe ligaments there are four which are particularly obſervable, and which ſerve to move the body in any direction. There runs all along this body a ſlit or crack, which pierces very deeply into its ſubſtance, and divides it as it were into two longitudinal ſections; this is properly a canal, and along this is thrown the liquor which ſerves to form the threads; and it is in this canal or ſlit that theſe threads are moulded into their form. Externally, this appears only a ſmall crack or ſlit, becauſe the two fleſhy ſections of the parts almoſt meet and cover it, but it is rounded and deep within, and is ſurrounded with circular fibres. This canal is carried regularly on from the tip of the tongue, as it is called, to its baſe, where it becomes cylindric; the cylinder in this part being no other than a cloſe tube or pipe, in which this open canal terminates. The cylindric tube contains a round olong body, of the nature of the threads, except that it is much larger; and from the extremity of this all the threads are produced, this ſerving as a great cable to which all the other little cordages diſperſed towards different parts are fixed. The tube or pipe in which this large thread is lodged, ſeems the reſervoir of the liquor of which the other threads are formed; all its internal ſurface being furniſhed with glands for its ſecretion.

The muſcle, like many other ſea-fiſhes, abounds in this liquor; and if at any time one touch with a finger the baſe of this ſpinning organ, one draws away with it a viſcous liquor in form of ſeveral threads, like thoſe of the caterpillar, ſpider, and the other ſpinning land-animals. The threads fix themſelves with equal eaſe to the moſt ſmooth and gloſſy, as to rougher bodies; if the muſcles are kept in glaſs-jars of ſea-water, they as firmly faſten themſelves to the glaſs as to any other body.

Muſcles, be they ever ſo young, have this property of ſpinning; and by this means they faſten themſelves in vaſt numbers to any thing which they find in the ſea. Mr Reaumur has ſeen them when as ſmall as millet ſeeds, ſpin plentifully; tho' their threads, proportioned to their own weight, are much finer and ſmaller than thoſe of larger muſcles.

It is a queſtion yet undetermined, whether the muſcle has a power of breaking or otherwiſe getting rid of its threads, in order to its removing from the place where it is once fixed; but it appears probable that they have not, and that they muſt remain where they have once faſtened themſelves, tho' their deſtruction be the conſequence of it. Mr Reaumur tried this experiment in his jars: when they had well fixed themſelves to the ſides of them, he poured off part of the ſalt-water, ſo that it became the intereſt of the fiſh to leave their hold and go lower down, but they ſeemed to have no power to effect this.

The common muſcle affords the curious obſerver a very pleaſing object of examination by the microſcope. The tranſparent membrane, which immediately appears on opening the ſhell, ſhews the circulation of the blood for a long time together through an amazing number of veſſels. And Mr Lewenhoek, in ſeveral which he diſſected, diſcovered numbers of eggs or embryo muſcles in the ovarium, appearing as plainly as if he had ſeen them by the naked eye, and all lying with their ſharp ends faſtened to the ſtring of veſſels by which they receive nouriſhment. The minute eggs, or embryos, are by the parent placed in due order, and in a very cloſe arrangement on the outſide of the ſhell, where, by means of a gluey matter, they adhere very faſt, and continually increaſe in ſize and ſtrength, till becoming perfect muſcles, they fall off and ſhift for themſelves, leaving the holes where they were placed, behind them.

This abundance of muſcle-ſhells very plainly ſhew when examined by the microſcope, and ſometimes they are in the number of 2000 or 3000 on one ſhell: but it is not certain that theſe have been all fixed there by the muſcle within; for theſe fiſh uſually lying in great numbers near one another, the embryos of one are often affixed to the ſhell of another. The fringed edge of the muſcle, which Lewenhoek calls the *beard*, has in every the minuteſt part of it ſuch variety of motions as is inconceivable; for being compoſed of longiſh fibres, each fibre has on both ſides a vaſt many moving particles.

From the common muſcles abundance of ſmall pearls, called *ſeed-pearls*, were, till of late, procured for medical purpoſes; but they are now diſuſed ſince it became generally known, that the cheaper teſtaceous powders were equally efficacious with theſe. Pearls are alſo found in the two laſt ſpecies.—Muſcles ſometimes diſagree with thoſe who eat them, bringing on ſwellings, difficulty of breathing, blotches, and ſometimes even death. The cure is oil mixed with ſalt water.

MYUS, (anc. geog.), one of the twelve towns of Ionia; ſeated on the Meander, at the diſtance of 30 ſtadia from the ſea. In Strabo's time it was incorporated with the Mileſians, on account of the paucity of its inhabitants, from its being formerly overwhelmed with water; for which reaſon the Ionians conſigned its ſuffrage and religious ceremonies to the people of Miletus. Artaxerxes allotted this town to Themiſtocles, in order to furniſh his table with proviſions. The town now lies in ruins.

MYXINE, the HAG; a genus of inſects belonging to the order of vermes inteſtini. It hath a ſlender body. carinated beneath; mouth at the extremity, cirrated; the two jaws pinnated; an adipoſe or rayleſs fin round the tail and under the belly. The only remarkable ſpecies is the glutinoſa, about eight inches long. It inhabits the ocean; enters the mouths of fiſh when on the hooks of lines that remain a tide under water, and totally devours the whole, except ſkin and bones. The Scarborough fiſhermen often take it in the robbed fiſh, on drawing up their lines. Linnæus attributes to it the property of turning water into glue.

N.

N Nabonassar.

N, A liquid consonant, and the 13th letter of the Greek, Latin, English, &c. alphabets.

The *n* is a nasal consonant: its sound is that of a *d*, passed through the nose; so that when the nose is stopped by a cold, or the like, it is usual to pronounce *d* for *n*. M. l'Abbé de Dangeau observes, that in the French, the *n* is frequently a mere nasal vowel, without any thing of the consonant in it. He calls it the Sclavonic vowel. The Hebrews call their *n nun*, which signifies child, as being supposed the offspring of *m*; partly on account of the resemblance of sound, and partly on that of the figure. Thus from the *m*, by omitting the last column, is formed *n*; and thus from the capital N, by omitting the first column, is formed the Greek minuscule ν. Hence for *biennies*, &c. the Latins frequently use *bimus*, &c. and the same people convert the Greek ν, at the end of a word into an *m*, as φαρμακον, *pharmacum*, &c. See M.

N before *p*, *b*, and *m*, the Latins change into *m*, and frequently into *l* and *r*; as in *in-ludo*, *illudo*; *in-rigo*, *irrigo*, &c.: in which they agree with the Hebrews, who, in lieu of *nun*, frequently double the following consonants; and the Greeks do the same; as when for *Manlius*, they write Μαλλιος, *&c.* The Greeks also, before κ, γ, χ, ν, changed the ν into γ: in which they were followed by the ancient Romans; who, for *Angulus*, wrote *Aggulus*; for *anceps*, *ag-ceps*, *&c.*

The Latins retrench the *n* from Greek nouns ending in ων; as Λεων, *Leo*; Δρακων, *Draco*: on the contrary, the Greeks add it to the Latin ones ending in ο; as Κατων, Νερων, for *Cato*, *Nero*.

N, among the ancients, was a numeral letter, signifying 900; according to the verse in Baronius,

N, quoque nongentos numero designat habendos.

And when a line was struck over it, $\bar{N}$, nine thousand. Among the ancient lawyers *N. L.* stood for *non liquet*, i. e. the cause is not clear enough to pass sentence upon. N, or N°, in commerce, *&c.* is used as an abbreviation of *numero*, number.

NABIS, tyrant of Sparta, reigned about 204 B. C.; and is reported to have exceeded all other tyrants so far, that, upon comparison, he left the epithets of *gracious* and *merciful* to Dionysius and Phalaris. He is said to have contrived an instrument of torture in the form of a statue of a beautiful woman, whose rich dress concealed a number of iron spikes in her bosom and arms. When any one therefore opposed his demands, he would say, "If I have not talents enough to prevail with you, perhaps my woman Apega may persuade you." The statue then appeared; which Nabis taking by the hand, led up to the person, who, being embraced by it, was thus tortured into compliance. He reigned 14 years, and was slain in battle.

NABOB, a viceroy, or governor of one of the provinces of the Mogul's empire.

NABONASSAR, first king of the Chaldæans, or Babylonians; memorable for the Jewish æra which bears his name, which is generally fixed in 3257, beginning on Wednesday February 26th in the 3967th of the Julian period, 747 years before Christ. The Babylonians revolting from the Medes, who had overthrown the Assyrian monarchy, did, under Nabonassar, found a dominion, which was much increased under Nebuchadnezzar. It is probable, that this Nabonassar is that Baladan in the second of Kings xx. 12. father of Merodach, who sent ambassadors to Hezekiah. See 2 Chron. xxxii.

Nabopolassar Nævius.

NABOPOLASSAR, king of Babylon: he joined with Astyages the Mede, to destroy the empire of Assyria; which having accomplished, they founded the two empires of the Medes under Astyages, and the Chaldeans under Nabopolassar, 627 B. C.

NABUCHADNEZZAR, or NABUCHODONOSOR II. king of Assyria, son of Nabopolassar, and styled the *Great*, was associated by his father in the empire, 667 B. C. and the following year he took Jehoiakim king of Judah prisoner, and proposed to carry him and his subjects in captivity into Babylon; but upon his submission, and promising to hold his kingdom under Nabuchodonosor, he was permitted to remain at Jerusalem. In 603 B. C. Jehoiakim attempted to shake off the Assyrian yoke, but without success; and this revolt brought on the general captivity. Nabuchadnezzar having subdued the Ethiopians, Arabians, Idumæans, Philistines, Syrians, Persians, Medes, Assyrians, and almost all Asia; being puffed up with pride, caused a golden statue to be set up, and commanded all to worship it; which Daniel's companions refusing to do, they were cast into the fiery furnace. But as he was admiring his own magnificence, by divine sentence, he was driven from men, and did eat grass as oxen, that is, he imagined himself to be one. At the end of seven years his reason returned to him, and he was restored to his throne and glory. He died 562 B. C. in the 43d year of his reign; in the 5th of which happened that eclipse of the sun mentioned by Ptolemy, which is the surest foundation of the chronology of his reign.

NADIR, in astronomy, that point of the heavens which is diametrically opposite to the zenith, or point directly over our heads.

NAERDEN, a strong town of the United Provinces in Holland, seated at the head of the canals of the province. The foundations of it were laid by William of Bavaria, in 1350. It was taken by the Spaniards in 1572, and by the French in 1672; but it was retaken by the prince of Orange the next year. It stands at the south end of the Zuyder-Zee, in E. Long. 5. 3. N. Lat. 51. 22.

NÆVIUS (Cneius), a famous poet of Campania, was bred a soldier, but quitted the profession of arms, in order to apply himself to poetry, which he prosecuted with great diligence; and composed a history in verse, and a great number of comedies. But it is said, that

that his firſt performance of this laſt kind ſo diſpleaſed Metellus, on account of the ſatyrical ſtrokes it contained, that he procured his being baniſhed from the city; on which he retired to Utica in Africa, where he at length died, 202 B. C. We have only ſome fragments left of his works.

NÆVUS, a mole on the ſkin, generally called a *mother's mark;* alſo the tumour known by the name of a *wen.*

All preternatural tumours on the ſkin, in the form of a wart or tubercle, are called *excreſcences;* by the Greeks they are called *acrothymia;* and when they are born with a perſon, they are called *nævi materni*, or *marks from the mother.* A large tumour depending from the ſkin is denominated *ſarcoma.* Theſe appear on any part of the body: ſome of them differ in their colour from the reſt of the ſkin; whilſt others are red, black, &c. Their ſhapes are various; ſome reſembling ſtrawberries, others grapes, &c. Heiſter adviſes their removal by means of a ligature, a cautery, or a knife, as circumſtances beſt ſuit.

As to the tumour called a *wen*, its different ſpecies are diſtinguiſhed by their contents. They are encyſted tumours; the matter contained in the firſt three following is inſpiſſated lymph, and that in the fourth is only fat. Monſ. Littre is the firſt who hath particularly deſcribed the fourth kind; and to the following purpoſe he ſpeaks of them all. A wen is ſaid to be of three ſorts, according to the kind of matter it contains: thoſe whoſe contents reſemble boiled rice, or curds, or a bread-poultice, is called *atheroma;* if it reſembles honey, it is named *meliceris;* and if it is like ſuet, it is denominated *ſteatoma:* but there is a fourth ſort, which may be called *lipome*, becauſe of its fat contents reſembling greaſe. He ſays that he hath ſeen one on the ſhoulders of a man, which was a thin bag, of a tender texture, full of a ſoft fat, and that it had all the qualities of common greaſe. And though the fat in the lipome reſembles that in the ſteatoma, yet they cannot be the ſame: for the matter of the ſteatoma is not inflammable, nor does it melt; or if it does, it is with great difficulty and imperfectly; whereas it is the contrary with the lipome. When the man who had the above-named lipome was fatigued, or had drank freely of ſtrong liquors, his lipome was inflamed for ſome days after, and its contents rarefying increaſed the ſize of the tumour.

The lipome ſeems to be no other than an enlargement of one or more of the cells of the adipoſe membrane, which is filled only with its natural contents. Its ſoftneſs and largeneſs diſtinguiſh it in general from the other ſpecies, though ſometimes the fatty contents will be ſo hard as to deceive. As this kind of wen does not run between the muſcles, nor is poſſeſſed of any conſiderable blood-veſſels, it may always be cut off with eaſe and ſafety.

As to the other kind of wens, their extirpation may or may not be attempted, according as their ſituation is with reſpect to adjacent veſſels, the wounding of which would endanger the patient's life.

NAGERA, or NAGARA, a town of Spain, in Old Caſtile, and the territory of Rioja, with the title of a duchy and fortreſs; famous for a battle fought in its neighbourhood in 1369. It is ſituated in a fertile country, on a brook called *Naſerilla.* W. Long. 2. 20. N. Lat. 42. 25.

NAGRACUT, a town of India, the capital of a kingdom of the ſame name in the dominions of the Great Mogul, with a rich temple to which the Indians go in pilgrimage. It is ſeated on the river Ravi. E. Long. 78. 10. N. Lat. 33. 12.

NAHUM, or the *Prophecy of* NAHUM, a canonical book of the Old Teſtament.

NAHUM, the ſeventh of the 12 leſſer prophets, was a native of Elkoſhai, a little village of Galilee. The ſubject of his prophecy is the deſtruction of Nineveh, which he deſcribes in the moſt lively and pathetic manner; his ſtyle is bold and figurative, and cannot be exceeded by the moſt perfect maſters of oratory. This prophecy was verified at the ſiege of that city by Aſtyages, in the year of the world 3378, 622 years before Chriſt.

NAIADES, in pagan mythology, the nymphs of rivers and fountains, who were adored by the pagans as a kind of inferior deities, and were repreſented as young and beautiful virgins.

NAIANT, in heraldry, a term uſed in blazoning fiſhes, when borne in an horizontal poſture, as if ſwimming.

NAIL, UNGUIS, in anatomy. See there, n° 80.

NAILS, in building, &c. ſmall ſpikes of iron, braſs, &c. which being drove into wood, ſerve to bind ſeveral pieces together, or to faſten ſomething upon them.

NAIL, is alſo a meaſure of length, containing the 16th part of a yard.

NAILING *of Cannon.* When circumſtances make it neceſſary to abandon cannon, or when the enemy's artillery are ſeized, and it is not however poſſible to take them away, it is proper to nail them up, in order to render them uſeleſs; which is done by driving a large nail or iron ſpike into the vent of a piece of artillery, to render it unſerviceable. There are various contrivances to force the nail out, as alſo ſundry machines invented for that purpoſe, but they have never been found of general uſe; ſo that the beſt method is to drill a new vent.

One Gaſper Vimercalus was the firſt who invented the nailing of cannon. He was a native of Bremen, and made uſe of his invention firſt in nailing up the artillery of Sigiſmund Malateſta.

NAIN (Lewis Sebaſtian de), one of the moſt learned and judicious critics and hiſtorians France has produced, was born in 1637. He was remarkable for his humility and piety, and died in 1698. His principal works are, 1. Memoirs on the eccleſiaſtical hiſtory of the ſix firſt ages of the church, 16 vols 4to. 2. The hiſtory of the emperors, 6 vols 4to.

NAIRN, a county of Scotland, comprehending the weſt part of Murray. It is bounded on the north by Murray frith, on the weſt and ſouth by Inverneſs, and on the eaſt by Elgin. The length of it amounts to 20 miles, and the breadth to 14. The air is temperate and ſalubrious, and the winters are remarkably mild. The face of the country is rough and mountainous; yet there are ſome fruitful ſtraths, or valleys, which produce good crops of oats and barley; but in general the country is much better adapted for paſturage. Here are alſo large woods of fir, and other trees, that afford ſhelter to the game, of which there is great plenty. A ſtrath is a long, narrow valley, with a ri-

ver running through the bottom. Of thefe, the moft remarkable in this county, are Strath-nairn, on the river of that name, in the fouth-weft part of the fhire; and on the fouth-eaft fide, Strath-erin, on both fides of Findhorne river. Nairn is well watered with ftreams, rivulets, and lakes, abounding with fifh. In the fouthern part there is a fmall lake, called *Moy*, furrounding an ifland, on which there is a caftle belonging to the laird of M'Intofh: but the greater part of the fhire is peopled by the Frafers, a warlike Highland clan, whofe chief, the Lord Lovat, loft his life on a fcaffold, for having been concerned in the late rebellion. Here is a great number of villages; but no towns of note, except Nairn, fuppofed to be the *Tuæfis* of Ptolemy, fituated at the mouth of the river which bears the fame name; a royal borough, which gave a title of *lord* to an ancient family, forfeited in the rebellion of 1715. The harbour, which opened in the Murray frith, is now choaked up with fand; and the commerce of the town is too inconfiderable to deferve notice. The people in general fubfift by feeding fheep and black cattle. About four miles from Nairn ftands the caftle of Calder, on the river of that name, belonging to a branch of the family of Campbell. In this neighbourhood we find a quarry of free-ftone, and many figns of copper. About fix miles to the north-weft of Nairn, a new fort hath been lately built by order of the government, at a place called *Ardefeer*, a fmall ifthmus upon the Murray frith, which it is intended to command.

NAISSANT, in heraldry, is applied to any animal iffuing out of the midft of fome ordinary, and fhewing only his head, fhoulders, fore-feet, and legs, with the tip of his tail; the reft of his body being hid in the fhield, or fome charge upon it: in which it differs from *iffuant*, which denotes a living creature arifing out of the bottom of any ordinary or charge.

NAKED SEEDS, in botany, thofe that are not inclofed in any pod or cafe.

NAME, denotes a word whereby men have agreed to exprefs fome idea; or which ferves to denote or fignify a thing or fubject fpoken of. See WORD.

This the grammarians ufually call a *noun*, *nomen*, though their noun is not of quite fo much extent as our name. See NOUN.

Seneca, Lib. II. *de Beneficiis*, obferves, that there are a great number of things which have no name; and which, therefore, we are forced to call by other borrowed names. *Ingens eft*, fays he, *rerum copia fine nomine, quas cum propriis appellationibus fignare non poffumus, alienis accommodatis utimur:* which may fhew why, in the courfe of this dictionary, we frequently give divers fenfes to the fame word.

Names are diftinguifhed into *proper* and *appellative*.

Proper NAMES, are thofe which reprefent fome individual thing or perfon, fo as to diftinguifh it from all other things of the fame fpecies; as, *Socrates*, which reprefents a certain philofopher.

Apellative or *General* NAMES, are thofe which fignify common ideas; or which are common to feveral individuals of the fame fpecies; as, *horfe*, *animal*, *man*, *oak*, &c.

Proper names are either called *Chriftian*, as being given at baptifm; or furnames: The firft impofed for diftinction of perfons, anfwering to the Roman *prenomen*: The fecond, for the diftinction of families, anfwering to the *nomen* of the Romans, and the *patronymicum* of the Greeks.

Originally every perfon had but one name; as among the Jews, *Adam*, &c. among the Egyptians, *Bufiris*; among the Chaldees, *Ninus*; the Medes, *Aftyages*; the Greeks, *Diomedes*; the Romans, *Romulus*; the Gauls, *Divitiacus*; the Germans, *Ariovifius*; the Britains, *Caffibelan*; the Englifh, *Hengift*, &c. And thus of other nations, except the favages of Mount Atlas, whom Pliny and Marcellinus reprefent as *anonyme*, "namelefs"

The Jews gave the name at the circumcifion, *viz.* eight days after the birth: the Romans, to females the fame day, to males the ninth; at which time they held a feaft, called *nominalia*.

Since Chriftianity has obtained, moft nations have followed the Jews, baptizing and giving the name on the eighth day after the birth; except our Englifh anceftors, who, till of late, baptized and gave the name on the birth-day.

The firft impofition of names was founded on different views, among different people; the moft common was to mark the good wifhes of the parents, or to entitle the children to the good fortune a happy name feemed to promife. Hence, *Victor*, *Caftor*, *Fauftus*, *Statorius*, *Probus*, &c.

Accordingly, we find fuch names, by Cicero called *bona nomina*, and by Tacitus *faufta nomina*, were firft enrolled and ranged in the Roman mufters; firft called to ferve at the facrifices, in the foundation of colonies, &c.—And, on the contray, Livy calls Atrius Umber, *abominandi omnis nomen:* and Plautus, on occafion of a perfon named *Lyco*, i. e. "greedy wolf," fays;

Vofmet nunc facite conjecturam cæterum
Quid id fit hominis, cui Lyco *nomen fiet.*

Hence, Plato recommends it to men to be careful in giving happy names; and the Pythagoreans taught exprefsly, that the minds, actions, and fucceffes of men, were according to their names, genius, and fate. Thus Panormitan, *ex bono nomine oritur bona præfumptio*; and the common proverb, *Bonum nomen bonum omen:* and hence the foundation of the onomomantia. See ONOMOMANTIA.

Hence Camden takes it for granted, that the names, in all nations aud languages, are fignificative, and not fimple founds for mere diftinction fake. This holds not only among the Jews, Greeks, Latins. &c. but even the Turks; among whom, Abdalla fignifies *God's fervant*; Soliman, *peaceable*; Mahomet, *glorified*, &c. And the favages of Hifpaniola, and throughout America, who, in their languages, name their children, *Gliftering Light*, *Sun Bright*, *Fine Gold*, &c.; and they of Congo, by the names of precious ftones, flowers, &c.

To fuppofe names given without any meaning, however by the alteration of languages their fignification may be loft, that learned author thinks is to reproach our anceftors; and that contrary to the fenfe of all ancient writers. Porphyry notes, that the barbarous *names*, as he calls them, were very emphatical, and very concife: and accordingly, it was efteemed a duty to be φερωνυμοι, or *fui nominis homines:* as Severus, Probus,

Probus, and Aurelius, are called *ſui nominis imperatores.*

It was the uſual way of giving names, to wiſh the children might diſcharge their names.—Thus when Gunthram king of France named Clotharius at the font, he ſaid, *Creſcat puer, & hujus ſit homines executor.*

The ancient Britons, Camden ſays, generally took their names from colours, becauſe they painted themſelves; which names are now loſt, or remain hid among the Welſh. When they were ſubdued by the Romans, they took Roman names, ſome of which ſtill remain, corrupted; though the greateſt part became extinct upon the admiſſion of the Engliſh Saxons, who introduced the German names, as *Cridda, Penda, Oſwald, Edward,* &c.—The Danes, too, brought with them their names; as *Suayne, Harold, Knute,* &c. The Normans, at the Conqueſt, brought in other German names, as originally uſing the German tongue; ſuch as *Robert, William, Richard, Henry, Hugh,* &c. after the ſame manner as the Greek names: *Aſpaſius, Boethius, Symmachus,* &c. were introduced into Italy upon the diviſion of the empire. After the Conqueſt, our nation, which had ever been averſe to foreign names, as deeming them unlucky, began to take Hebrew names; as *Matthew, David, Sampſon,* &c. The various names anciently or at preſent obtaining among us, from what language or people ſoever borrowed, are explained by Camden in his Remains. As to the period when names began to be multiplied, and ſurnames introduced, &c. ſee SURNAME.

Of late years it has obtained among us to give ſurnames for Chriſtian names; which ſome diſlike, on account of the confuſion it may introduce. Camden relates it as an opinion, that the practice firſt began in the reign of Edward VI. by ſuch as would be godfathers, when they were more than half fathers. Upon which ſome were perſuaded to change their names at confirmation; which, it ſeems, is uſual in other countries.—Thus, two ſons of Henry II. of France, chriſtened *Alexander* and *Hercules,* changed them at confirmation into *Henry* and *Francis.* In monaſteries, the religious aſſume new names at their admittance, to ſhew they are about to lead a new life, and have renounced the world, their family, and even their name: *v. g.* ſiſter Mary *of the Incarnation,* brother Henry *of the holy Sacrament,* &c. The popes alſo changed their name at their exaltation to the pontificate; a cuſtom firſt introduced by Pope Sergius, whoſe name till then, as Platina informs us, was *Swineſnout.* But Onuphrius refers it to John XII or XIII.; and at the ſame time adds a different reaſon for it from that of Platina, viz. that it was done in imitation of St Peter and St Paul, who were firſt called *Simon* and *Saul.*

Among the ancients, thoſe deified by the Heathen conſecrations, had new names given them; as Romulus was called *Quirinus;* Melicertes, *Portunus* or *Portumnus,* &c.

New names were alſo given in adoptions, and ſometimes by teſtament: thus L. Æmilius, adopted by Scipio, took the name of *Scipio Africanus;* and thus Auguſtus, who at firſt was called *C. Octavius Thurinus,* being adopted by the teſtament of Julius Cæſar into his name and family, took the name of *Caius Julius Cæſar Octavianus.*

Names were alſo changed at enfranchiſements into new cities. Thus Lucumo, at his firſt being made free of Rome, took the name *Lucius Tarquinius Priſcus,* &c.; and ſlaves, when made free, uſually aſſumed their maſters names. Thoſe called to the equeſtrian order, if they had baſe names, were always new named, *nomine ingenuorum veterumque Romanorum.* And among the primitive Chriſtians, it was the practice to change the names of the catechumens: Thus the renegado Lucianus, till his baptiſm, was called *Lucius.*

NAMUR, a province of the Netherlands, lying between the rivers Sambre and Maeſe; bounded on the north by Brabant, on the eaſt and ſouth by the biſhopric of Liege, and on the weſt by Hainault. It is pretty fertile; has ſeveral foreſts, marble quarries, and mines of iron, lead, and pit-coal; and is about 30 miles long, and 20 broad. Namur is the capital town.

NAMUR, a large, rich, and very ſtrong town of the Netherlands, capital of the county of Namur, with a ſtrong caſtle, ſeveral forts, and a biſhop's ſee. The moſt conſiderable forts are, Fort-William, Fort-Maeſe, Fort Coquelet, and Fort-Eſpinor. The caſtle is built in the middle of the town, on a craggy rock. It was beſieged by king William in 1695, who took it in the ſight of an army of 100,000 French, though there were 60,000 men in garriſon. Namur is now a barrier-town, and has a Dutch garriſon. It was ceded to the houſe of Auſtria in 1713, but taken by the French in 1746; and reſtored by the treaty of Aix-la-Chapelle. It is ſituated between two mountains, at the confluence of the rivers Maeſe and Sambre, in E. Long. 4. 57. N. Lat. 50. 25.

NANCI, a town of France, and capital of Lorrain, is ſituated on the river Meuſe, in the centre of the province. It is divided into the Old and New Towns, The firſt, though irregularly built, is very populous, and contains the ducal palace: the ſtreets of the New Town are as ſtraight as a line, adorned with handſome buildings, and a very fine ſquare. The primatial church is a magnificent ſtructure, and in that of the Cordeliers are the tombs of the ancient dukes. The two towns are ſeparated by a canal; and the new town was very well fortified, but the king of France has demoliſhed the fortifications. It has been taken and retaken ſeveral times; particularly by the French, to whom it was ceded in 1736, to enjoy it after the death of Staniſlaus.

NANKING, a city of China, and capital of the province of Kiang-nan. It is the largeſt in China, being 17 miles in circumference, and about three miles diſtant from the great river Yang-tiſe Chiang, from which there are canals cut, ſo large that veſſels may enter the town. This place is greatly fallen from its ancient ſplendour, for it had a magnificent palace, which is quite deſtroyed, as well as many ancient monuments, and a third part of the city itſelf is deſolate. The ſtreets are narrow, but handſome and well paved, and on each ſide are ſhops neatly furniſhed. The public buildings are mean, except a few temples, the city-gates, and a tower of porcelain 200 feet high. They have ſeveral manufactures of ſilk and wool. The number of the inhabitants are ſaid to be 1,000,000, without

without comprehending the garrifon of 40,000 men. E. Long. 119. 25. N. Lat. 32. 46.

NANSIO, an ifland of the Archipelago, a little to the north of the ifland of Santorino, 16 miles in circumference; but has no harbour. The mountains are nothing but bare rocks, and there are not fprings fufficient to water the fields. There are a vaft number of partridges, whofe eggs they deftroy every year to preferve the corn, and yet vaft numbers of them are always produced. The ruins of the temple of Apollo are yet to be feen, and confift chiefly of marble columns. E. Long. 26. 20. N. Lat. 36. 15.

NANTES, an ancient, rich, and very confiderable town of France, in Bretagne, with a bifhop's fee, an univerfity, and a mint. It is one of the moft confiderable places in the kingdom; contains the richeft merchants; and was formerly the refidence of the dukes of Bretagne, where they built a very ftrong caftle on the fide of the river, and which is ftrongly fortified. There are feveral parifhes, and a great many religious houfes, and the cathedral contains the tombs of the ancient dukes. There are feveral fine bridges over the river Loire, which is navigable. The fuburbs are fo large, on account of the number of people that come from all parts to fettle here, that they exceed the city. The Spaniards trade here with wine, fine wool, iron, filk, oil, oranges, and lemons; and they carry back cloth, ftuffs, corn, and hard-ware. The Dutch fend falt fifh, and all forts of fpices; and in return have wine and brandy. The Swedes bring copper; and the Englifh, lead, tin, and pit-coal. It was in this place that Henry IV. promulgated the famous edict in 1598, called the *Edict of Nantes*, and which was revoked in 1685. The territory of Nantes lies on both fides the Loire, and feeds a great number of cattle. Large veffels can come no higher than Port Launai, which is 12 miles from Nantes. W. Long. 1. 31. N. Lat. 47. 13.

NANTUEIL (Robert), the celebrated defigner and engraver to the cabinet of Lewis XIV. was born at Rheims in 1630. Though his father was but a petty fhopkeeper, he gave his fon a liberal education; who, having a tafte for drawing, cultivated it with fuch fuccefs, that he became the admiration of the whole town: but marrying young, and not being able to maintain his family, he took a journey to Paris, where he made his talents known by a ftratagem.—Seeing feveral abbés at the door of an eating-houfe, he afked the miftrefs for an ecclefiaftic of Rheims, whofe name he had forgot, but that fhe might eafily know him by a picture of him which he fhewed: the abbés crowding round, were fo charmed with it, that he feized the opportunity of offering to draw any of their pictures for a fmall matter. Cuftomers came fo faft that he foon raifed his price, and brought his family to Paris, where his reputation was quickly eftablifhed. He applied himfelf particularly to taking portraits in crayons, which he afterward engraved for the ufe of academical thefes; and in this way he did the portrait of the king, and afterward engraved it as big as the life; a thing never before attempted. The king was fo pleafed with it, that he created the place of defigner and engraver to the cabinet for him, with a penfion of 1000 livres. He died in 1678; and an entire collection of his prints amounts to upwards of 240.

NAPÆA, in botany; a genus of the polyginia order, belonging to the monadelphia clafs of plants. There are two fpecies; both of them with perennial roots, compofed of many thick flefhy fibres, which ftrike deep into the ground, and are connected at the top into large heads; the ftalks grow to feven or eight feet high, producing white flowers, tubulous at bottom, but fpreading open at top, and dividing into five obtufe fegments. Both thefe plants are natives of Virginia and other parts of North America: from the bark of fome of the Indian kinds a fort of fine hemp might be procured, capable of being woven into very ftrong cloth. They are eafily propagated by feed, which will thrive in any fituation.

NAPHTHA, in natural hiftory, a fluid mineral body, of a thin confiftence, bright and pellucid, of a ftrong fmell, very readily inflammable, and, when pure, burning away without leaving any refiduum.

The naphtha is found in confiderable quantities floating on the water of certain fprings, principally breaking out at the fides of hills in Perfia, Tartary, and fome parts of the empire of China; where, if a lighted candle be held near the furface, it takes fire and overfpreads the furface of the water for a great extent with a ftrong white flame, and emits a very difagreeable fmell. The genuine naphtha is very rare in Europe; it is not known to be any where naturally produced here, and what we fee of it is generally fophifticated. Diftilled by the retort, it yields an oil fomewhat thinner than it was originally, and of a weaker fmell. The fubftance remaining at the bottom of the retort, has much the refemblance of amber; and Dr Hill thinks it highly probable, that the origin of all the amber is from the fame fort of principle; nay, he tells us that he has fucceeded fo far in an attempt to make amber by this fluid and an acid drawn from the crude pyrites, that he has produced a friable, fomewhat pellucid matter, having all the properties of amber except the hardnefs and clearnefs, and yielding a true falt and oil of amber on diftillation. The medicinal virtues of the naphtha are the fame with that of the common petroleum, but in a lower degree. It is ufed externally on many occafions in Perfia; and is taken inwardly, a few drops for a dofe, in colics. The principal ufe of it, however, is for burning in lamps; and for this it is extremely well adapted.

NAPHTHALI, or NEPHTHALI, (Jofh. xix.) one of the tribes of Ifrael; having Zabulon on the fouth, Afher on the weft, the Jordan on the eaft, and on the north Antilibanus.

NAPIER. See NEPER.

NAPLES, a kingdom of Italy, comprehending the ancient countries of Samnium, Campania, Apulia, and Magna Græcia. It is bounded on all fides by the Mediterranean and Adriatic, except on the north-eaft, where it terminates on the Ecclefiaftical ftate. Its greateft length from fouth-eaft to north-weft is about 280 Englifh miles; and its breath from north-eaft to fouth-weft, from 96 to 120.

The ancient hiftory of this country falls under the articles ROME and ITALY; the prefent ftate of it, as well as of the reft of Italy, is owing to the conquefts of Charlemagne. When that monarch put an end to the kingdom of the Lombards, he obliged the dukes of Friuli, Spoleto, and Benevento, to acknowledge

1 Extent of the duchy of Beneven-

ledge him as king of Italy; but allowed them to exercife the fame power and authority which they had enjoyed before his conqueft. Of thefe three dukedoms Benevento was by far the moft powerful and extenfive, as it comprehended almoft all the prefent kingdom of Naples; that part of Farther Calabria beyond the rivers Savuto and Peto, a few maritime cities in Hither Calabria, with the city of Acripoli, and the promontory in its neighbourhood called *Capo di Licofa;* and laftly, the dukedoms of Gaeta, Naples, and Amalfi, which were very inconfiderable, and extended along the fhore only about 100 miles, and were interrupted by the Gaftaldate or county of Capua.

2 Arechis duke of Benevento revolts from Charlemagne.

This flourifhing and extenfive dukedom was at this time governed by Arechis, who had married one of the daughters of the laft king of the Lombards, and had fubmitted, and taken the oath of allegiance to the emperor Charles. However, a few years after, he renounced his allegiance to the Franks, declared himfelf an independent fovereign, and was acknowledged as fuch by all the inhabitants of his duchy. To ftrengthen himfelf againft Pepin king of Italy, who refided at Ravenna, he enlarged and fortified the city of Benevento, and likewife built Salerno on the fea-coaft, furrounding it with a very ftrong and high wall. He engaged in feveral wars with the Greeks, whom he fometimes obliged to give him hoftages; but having invaded the territories of the pope, whom Pepin could not affift, Charlemagne was prevailed on to return to Italy. Arechis, unable to oppofe fuch a formidable enemy, fent his eldeft fon, Romuald, to Rome, with an offer of fubmiffion: but, at the inftigation of the pope, Charles refufed the offer, and detained his fon prifoner; after which he ravaged the country, and made himfelf mafter of Capua. Other deputies, however, proved more fuccefsful; and, in the year 787, a peace was concluded on thefe conditions: That Arechis and the Beneventans fhould renew their allegiance to the Franks; that he fhould pay a yearly tribute to Pepin; deliver up all his treafure; and give his fon Grimoald and his daughter Adelgifa, with twelve others, as hoftages for his fidelity: however, after many intreaties, Adelgifa was reftored to her father.

3 Submits.

4 Revolts a fecond time.

Charles had no fooner left Italy, than Arechis forgot all his engagements, and began to negociate with Irene, emprefs of Conftantinople, and her fon Conftantine, for expelling the Franks out of Italy. For himfelf, he defired the honour of patriciate, and the dukedom of Naples with all its dependencies; and, in return, promifed to acknowledge the Greek emperor as his fovereign, and to live after the manner of the Greeks. He required, however, to be fupported by a Greek army; and that his brother-in-law Adalgifus, fon to Defiderius the laft king of the Lombards, fhould be fent over into Italy, to raife a party among his countrymen. Thefe conditions were readily accepted, on condition that prince Romuald fhould be fent as an hoftage; ambaffadors were fent to Naples with the enfigns of the patrician order, namely the mantle of cloth of gold, the fword, the comb, and the fandals: but before the ceremony could be performed, prince Romuald died, and foon after him his father; whofe death was fuppofed to have been haftened by that of his fon.

After the death of Arechis, the Beneventans fent a moft fubmiffive embaffy to Charlemagne, intreating him to fend them Grimoald, the late king's fon, and only lawful heir to his crown; threatening at the fame time to revolt if their prince was denied them. Charles readily granted their requeft, and allowed Grimoald to depart, after he had agreed to the following conditions, viz. That he fhould oblige the Lombards to fhave their beards; that, in writings, and on money, the name of the king fhould be put before that of the prince; and that he fhould caufe the walls of Salerno, Acerenza, and Confia, to be entirely demolifhed.—The new king was received by his fubjects with the utmoft joy; and for fome time continued faithful to his engagements, excepting only the laft article, which he either neglected or eluded. So far, however, was he from affifting the Greeks, that he gave notice of their machinations to Pepin king of Italy; raifed an army to oppofe his uncle Adalgifus; and being joined by Hildebrand duke of Spoleto, and Vinigife the general of Pepin, he attacked the Greeks in Calabria foon after they had landed, entirely defeated and took his uncle prifoner, and, as is faid, put him to a cruel death. Yet in a fhort time Grimoald contracted an alliance with the Greek emperor by marrying his niece Wanzia; and in the fifth year of his reign, a war broke out between him and Pepin, which continued for twelve years; at the end of which time a truce was concluded. Grimoald furvived this pacification only three years, and was fucceeded by his treafurer Grimoald II. who fubmitted to Charlemagne after the death of Pepin, and from this time the Beneventans were looked upon as tributaries of the weftern emperors. As yet, however, the city of Naples did not own allegiance to the dukes of Benevento, but was held by the eaftern emperors; and frequent wars took place between the Beneventans and Neapolitans. This happened to be the cafe when Grimoald II. afcended the throne. He concluded a peace with them: which however, was of no long continuance; for Theodore, governor of Naples, having granted protections to Dauferius a noble Beneventan, who had been concerned in a confpiracy againft his prince, Grimoald marched againft the city of Naples, and invefted it by fea and land. Theodore ftill refufed to deliver up the traitor, and a general engagement both by land and fea was the confequence; in which the Neapolitans were defeated with fo great flaughter, that the fea was ftained with their blood for more than feven days. Theodore then confented to deliver up Dauferius, with 8000 crowns for the expences of the war; and Grimoald not only pardoned Dauferius, but received him into favour: the traitor, however, reflecting on the heinoufnefs of his crime, was feized with remorfe; and went a pilgrimage to the holy land, carrying a large ftone in his mouth, by way of penance, which he never took out but at his meals.

5 Grimoald continues for fome time faithful to the Franks.

6 Is murdered, and fucceeded by Sico.

In the year 821, Grimoald was murdered by Radelchis count of Confia, and Sico gaftald of Acerenta, the latter of whom fucceeded to the dukedom of Benevento. Radelchis being foon after feized with remorfe, became a monk; while Sico affociated his fon Sicardo with him in the government; and both, being of an ambitions and reftlefs difpofition, fought a pretence for attacking the Neapolitans. This was

Naples.

ſoon found, and the city was inveſted by ſea and land. The walls were furiouſly battered; and part of them being beat down, Sico prepared for a general aſſault. Stephen, at that time duke of Naples, pretended to ſubmit; but, that he might prevent the city from being pillaged, intreated Sico to put off his entry till the morning, and in the mean time ſent out his mother and his two children as hoſtages. Sico conſented to his requeſt; but next morning found the breach built up, and the Neapolitans prepared for their defence. Exaſperated at their prefidy, he renewed his attacks with vigour, but without any ſucceſs; the beſieged defending themſelves with the utmoſt obſtinacy. At laſt, perceiving that they ſhould not be able to hold out much longer, they conſented to a peace on the following conditions, viz. That the Neapolitans ſhould pay an annual tribute to the princes of Benevento, and conſent to the tranſporting of the body of St Januarius from his church without the walls of Naples to Benevento. Theſe conditions being ratified, Sico returned with great honour to Benevento; but ſoon after renewed the war, under pretence that the Neapolitans had neglected to pay the ſtipulated ſum; and hoſtilities continued till his death, which happened in 833.

7 Naples beſieged by Sico.

8 And by his ſucceſſor Sicardo.

Sico was ſucceeded in the government of Benevento by his ſon Sicardo, who had married the daughter of Dauferius; and being influenced by the evil counſels of Roffrid his wife's brother, oppreſſed his ſubjects to ſuch a degree that they conſpired againſt his life. He beſieged Naples with a powerful army, and took poſſeſſion of Acerra and Atella, both of which he fortified. But Bonus, the Neapolitan duke, defended himſelf ſo vigorouſly, that the Beneventans were obliged to retire, and even to abandon Acerra and Atella, the fortifications of which were immediately demoliſhed. At laſt Sicardo agreed to a peace for five years, on the interceſſion of Lothaire, emperor and king of Italy; but his chief motive was thought to have been the fear of the Saracens, whom the duke of Naples had called over from Africa to his aſſiſtance: for no ſooner were they ſent back, than Sicardo attempted to delay the concluſion of the treaty; but the emperor interpoſing his authority, a peace was concluded in the year 836, after the war had continued, with very little intermiſſion, for 16 years.

9 The Saracens called in by the duke of Naples.

Soon after the concluſion of this peace, the Saracens landed at Brindiſi; and having made themſelves maſters of the place, ravaged all the neighbouring country. Sicardo marched againſt them with a numerous army; but the Saracens having dug a great number of ditches which they ſlightly covered over, found means to draw the Beneventans in among them, whereby they were repulſed with great loſs. However, Sicardo, having reinforced his army, marched again to attack them; but the Saracens, deſpairing of ſucceſs, pillaged and burnt Brindiſi, and then retired with their booty, and a great many captives, to Sicily. Sicardo then, without any apparent provocation, attacked the city of Amalfi, levelled its walls with the ground, carried off all its wealth, and the body of its tutelar ſaint Triphomen. A great many of the inhabitants were tranſported to Salerno; and by promoting alliances between the inhabitants of both places, he endeavoured to unite Amalfi to his own principality as firmly as poſſible.

Naples.

During all theſe tranſactions, Sicardo had tyrannized over his ſubjects in ſuch a manner, that at laſt he became intolerable. Among other acts of injuſtice, he impriſoned his own brother Siconolphus; compelled him to turn prieſt; and afterwards ſent him bound to Tarento, where he cauſed him to be ſhut up in an old tower that had been built for a ciſtern. By ſuch acts of tyranny his nobles were provoked to conſpire againſt him; and in the year 839 he was murdered in his tent.

10 Sicardo murdered by Radelchis, which brings on a civil war.

On the death of Sicardo, Radelchis, his ſecretary or treaſurer, was unanimouſly elected prince of Benevento; but Siconolphus, the laſt king's brother, having regained his liberty, formed a great party againſt the new prince. Radelchis did not fail to oppoſe him with a formidable army; and a moſt ruinous civil war enſued. Both parties by turns called in the Saracens; and theſe treacherous allies acted ſometimes againſt one, and ſometimes againſt the other; or turned their arms againſt both, as ſeemed moſt ſuitable to their own intereſt. Thus the war continued with the utmoſt animoſity for 12 years, during which time the principality was almoſt entirely ruined; till at laſt the emperor Lewis interpoſed, and obliged the competitors to agree to a partition of the principality: by this treaty, Radelchis promiſed to acknowledge Siconolphus and his ſucceſſors as lawful princes of the principality of Salerno, which was declared to contain Tarento, Latiniano, Caſſano, Coſſenzo, Laino, Lucania, Conſia, Montella, Rota, Salerno, Sarno, Ciraterium, Furculo, Capua, Feano, Sora, and the half of the Gaſtaldate of Acerenza, where it joins Latiano and Conſia. The boundary betwixt Benevento and Capua was fixed at St Angelo ad Cerros; Alli Peregrini was made the boundary betwixt Benevento and Salerno, and Staffilo betwixt Benevento and Conſia. The monaſteries of Monte Caſſino and St Vincent were declared to be immediately under the protection of the emperor: both princes ſtipulated that no hoſtilities ſhould be committed by either, againſt the ſubjects of each other; and promiſed to join their forces, in order to drive out the Saracens. Soon after this pacification, however, both Radelchis and Siconolphus died; the former appointing his ſon Radelgarius, or Radelcar, to ſucceed him; and the latter leaving an infant ſon, Sico, to the care of his godfather, Peter.

11 The principality divided.

12 Unſucceſsful war with the Saracens.

The war with the Saracens proved very unſucceſsful; neither the united efforts of the princes, nor the aſſiſtance of the emperor Lewis himſelf, being able to expel the infidels; and, in 854, Arechis, the ſon and ſucceſſor of Radelchis, was obliged to pay them an annual ſubſidy. Two years after, Lando, count of Capua, revolted from the prince of Salerno, and could not be reduced. In the mean time, Sico, the lawful prince of Salerno, had been poiſoned by count Lando, and the principality uſurped by Ademarius, the ſon of Peter above-mentioned; but, in 861, Ademarius himſelf was ſeized and impriſoned by Guaferius, the ſon of Dauferius formerly mentioned. This was occaſioned by his cruelty and rapacioufneſs, which entirely alienated the hearts of his ſubjects from him, and encouraged Guaferius to become the head of the conſpirators. The Saracens in the mean time committed terrible

Naples. terrible ravages throughout the Beneventan territories which at laft obliged Adelgife to enter into an alliance with Guaferius, and both together fent a moft humble embaffy to the emperor Lewis, requefting him to take them under his protection. About the fame time an embaffy arrived from Conftantinople, propofing a junction of the forces of the eaftern and weftern empires againft the infidels; upon which Lewis gave orders for affembling a formidable army. But in the mean time Adelgife fell off from his alliance, and made peace with the Saracens; nay, according to fome, he encouraged them in their incurfions, and it was at his defire that they invaded the duchy of Capua, and afterwards that of Naples, which they ravaged in a moft barbarous manner. The Neapolitans, in conjunction with the duke of Spoleto and the count of Marfi, endeavoured to oppofe them; but being defeated, the Saracens continued their ravages with redoubled fury, and retired to Bari, which was their capital city, with an immenfe booty.

In 866, Lewis arrived at Sora with his army; and having marched to Capua, was there joined by Landulph, the bifhop and count, with a body of Capuans: but Landulph foon after perfuading his countrymen to defert, Lewis marched againft that city, which he took after a fiege of three months, and almoft totally deftroyed. In the end of the year he was joined by Guaferius with his quota of troops, having ordered the eyes of Ademarius to be put out in his abfence. Lewis confirmed him in the principality, and marched with his army to Benevento, where Adelgife received him with great refpect. Having reduced fome inconfiderable places belonging to the Saracens, Lewis foon after invefted Bari; but as the Saracens received continual fupplies from their countrymen fettled in Sicily, and befides were protected by the Neapolitans, he could not reduce the place till the year 871, tho' he had received confiderable affiftance from his brother

13 They are at laft expelled.

Lotharius, and the Greek emperor had fent him a fleet of 200 fail. The expulfion of the Saracens was completed the fame year by the taking of Tarento; after which the emperor returned with great glory to Benevento, refolving next to carry his arms into Sicily, and expel the infidels from thence alfo. But his future fchemes of conqueft were fruftrated by a quarrel between him and Adelgife. The latter, pretending to have been infulted by the emprefs, and oppreffed by the French, feized the emperor himfelf, and kept him prifoner for 40 days. His imprifonment would probably have been of much longer continuance, had not

14 But foon return.

a body of Saracens arrived from Africa, who, being joined by fuch of their countrymen as had concealed themfelves in Italy, laid fiege to Salerno with an army of 30,000 men, ravaging the neighbouring country at the fame time with the utmoft barbarity. By this new invafion Adelgife was fo much alarmed, that he fet the emperor at liberty, but firft obliged him to fwear that he would not revenge the infult that had been offered him, and that he would never return to Benevento. Lewis having then joined his forces to thofe of the prince of Salerno, foon obliged the Saracens to raife the fiege of Salerno; but tho' they were prevented from taking that city, they entirely deftroyed the inhabitants of Calabria, leaving it, according to the expreffion of one of the hiftorians of that time, "as defolate as it was at the flood." Naples.

In the year 873, Lewis being abfolved from his oath by the pope, went to Benevento, and was reconciled to Adelgife; but foon after this reconciliation he died, and the Saracens continued their ravages to fuch a degree that the inhabitants of Bari were conftrained to deliver up their city to the Greeks. At the fame time the Salernitans, Neapolitans, Cajetans, and Amalfitans, having made peace with the Saracens, were compelled to agree to their propofal of invading the territories of the Roman pontiff. His holinefs exerted himfelf to the utmoft, both with fpiritual and temporal weapons, in order to defend his right; but was at 15 The pope becomes their tributary.

laft reduced to the neceffity of becoming a tributary to the infidels, and promifing to pay them a large fum annually.

In the mean time all Italy was thrown into the greateft confufion by the death of Charles the Bald, who died of poifon at Pavia, as he was coming to the pope's affiftance. Sergius duke of Naples continued a firm friend to the infidels; nor could he be detached from their interefts even by the thunder of a papal excommunication: but unluckily happening to fall into the hands of his brother Athanafius bifhop of Naples, the zeal of that prelate prompted him to put out his eyes, and fend him a clofe prifoner to Rome; for which the higheft encomiums were beftowed on him by the holy father.

In 878, Adelgife was murdered by two of his nephews; one of whom, by name *Gaideris*, feized the principality. About the fame time Landulph bifhop of Capua dying, a civil war enfued among his children, though their father's dominions had been divided among them according to his will. The princes of Salerno and Benevento, the duke of Spoleto, and Gregory the Greek governor of Bari and Otranto, took different fides in the quarrel, as they thought moft proper; and to complete the confufion, the new bifhop was expelled, and his brother, though a layman, chofen to that office, and even confecrated by the pope, who wrote to Guaferius, forbidding him to attack Capua under pain of excommunication. But though Guaferius was, in general, obedient to the pope's commands, he proved refractory in this particular, and laid fiege to Capua for two years fucceffively.

Thus the Capuan territories were reduced to the moft miferable fituation; being obliged to maintain at the fame time the armies of the prince of Benevento and the duke of Spoleto. The Saracens in the mean time took the opportunity of ftrengthening themfelves in Italy; and Athanafius, notwithftanding the great commendations he had received from the pope for putting out his brother's eyes, confented to enter into an alliance with them, in conjunction with whom he ravaged the territories of the pope, as well as thofe of Benevento and Spoleto, plundering all the churches, monafteries, towns, and villages, through which they paffed. At the fame time the prince of Salerno was obliged to grant them a fettlement in the neighbourhood of his capital; the duke of Geeta invited them to his affiftance, being oppreffed by the count of Capua; and even the pope himfelf was obliged to make peace with them, and to grant them a fettlement on the north fide of the Garigliano, where they fortified themfelves, and continued for more than 40 years.

Naples.

To put a ſtop to the confuſion which reigned in Italy, the pope now thought proper to reſtore the biſhop of Capua, who had been expelled, but allowed his brother to reſide in the city, and govern one half of the dioceſe; but notwithſtanding this partition, the civil diſſenſions continued with the utmoſt violence, the neareſt relations murdering or baniſhing each other, according as the fortune of the one or the other prevailed.—Athanaſius, notwithſtanding all the pope's remonſtrances, continued his alliance with the Saracens; in conjunction with whom he ravaged the territory of Benevento, and fomented the diviſions in Capua, in hopes of being able to make a conqueſt of it. At laſt his holineſs thought proper to iſſue a ſentence of excommunication againſt him: but this attached him to the Saracens more than ever; inſomuch that he ſent to Suchaim, king of the Saracens in Sicily, deſiring him to come over and command a great body of his countrymen who had ſettled at the foot of Mount Veſuvius. Suchaim accepted the invitation, and immediately turned his arms againſt Athanaſius; allowing his troops to live at diſcretion in the territory of Naples, where they raviſhed the women, and plundered the inhabitants. Theſe calamities were, by the ſuperſtitious Neapolitans, imagined to be a conſequence of the ſentence of excommunication; and therefore they uſed their utmoſt endeavours to perſuade the prelate to conclude a league with ſome Chriſtian prince, and renounce all connection with the infidels. In this they at laſt proved ſucceſsful, and Athanaſius concluded an alliance with Guaimarius prince of Salerno; in conſequence of which the Saracens were obliged to quit the Neapolitan territories, and retire to Agropoli. Athanaſius then directed his force againſt Capua, of which he made himſelf maſter in the year 882. The Saracens, however, ſtill continued their incurſions, and ravaged ſeveral provinces in ſuch a manner, that they became entirely deſolate.

Theſe confuſions continued for a long time; during which the Greeks found an opportunity of making themſelves maſters of Benevento, and had well nigh

16 become maſters alſo of Salerno; but in this they failed through the treachery of the biſhop, and in the year 896 they were totally expelled by the biſhop, four years after they had become maſters of it. In 915 the Saracens received ſuch an overthrow at Carigliano, that ſcarce one of them remained; however, a new body ſoon arrived from Africa, and infeſted the ſea-coaſts for ſome time longer. A war alſo enſued between Landulph and the Greeks; which concluded diſadvantageouſly for the former, who was obliged to ſubmit to the emperor of Conſtantinople in 943.

The Saracens almoſt entirely cut off.

In 961, Otho the Great, king of Germany, invaded Italy with a powerful army againſt Berengarius III. and, marching to Rome, received the imperial crown from the hands of the pope. In 964, he erected Capua into a principality, received homage from the other princes of Lombardy, and formed a deſign of recovering Puglia and Calabria from the Greeks. But in this laſt ſcheme he failed; and after various hoſtilities a treaty was concluded, and the young princeſs Theophania married to Otho's ſon, afterwards emperor.

All this time the Saracens continued their incurſions; and the Greeks had gained ground ſo much, that they were now in poſſeſſion of two thirds of the preſent kingdom of Naples; but in the year 1002 or 1003, the Normans firſt began to be remarkable in Italy. They had, about a century before, embraced Chriſtianity, and become very zealous in all the ſuperſtitions which were then practiſed. They were particularly zealous in viſiting ſacred places, eſpecially Rome, and the holy ſepulchre at Jeruſalem; and being naturally of a very martial diſpoſition, they forced through great bodies of Greeks and Saracens who oppoſed their paſſage. About this time, 40, or, as others write, 100, of theſe Normans, returning from Jeruſalem by ſea, landed at Salerno in the habit of pilgrims, where they were honourably received by Guaimarius. During their reſidence at Salerno, a great body of Saracens landed, and inveſted the city. Guaimarius, not being in a condition to oppoſe the invaders by force, was preparing to pay them a large ſum of money which they demanded, when the Normans propoſed to attack them; and, having got arms and horſes from the prince, they engaged the infidels with ſuch fury and bravery, that they entirely defeated them, and obliged them to fly to their ſhips. By this complete victory Guaimarius was filled with ſuch admiration of the valour of theſe ſtrangers, that he intreated them to remain in his country; offering them lands, and the moſt honourable employments: but not being able to prevail with them to ſtay in Italy, or even accept of his preſents; at their departure he ſent ſome ambaſſadors with them to Normandy, in veſſels loaded with exquiſite fruits, rich furniture for horſes, &c. in order to allure the valiant Normans to leave their own country. This kind invitation encouraged a Norman chief, named *Oſmond Drengot*, to ſettle in Italy about the year 1015; having killed another lord in a duel, which obliged him to leave his own country, in order to avoid the reſentment of his ſovereign, Robert duke of Normandy. In the mean time the city of Bari had revolted from the Greeks, and choſen one Mello for their leader, whoſe wife and children happened ſoon after to fall into the hands of their enemies, and were ſent priſoners to Conſtantinople. No ſooner, therefore, did Mello hear of the arrival of theſe adventurers, than he engaged them to aſſiſt him, and having drawn together a conſiderable army, defeated the Greeks with great ſlaughter, and obliged them to abandon their camp. In this engagement the Normans diſtinguiſhed themſelves by their bravery; and the news of their ſucceſs ſoon brought from Normandy an innumerable multitude of their countrymen, with their wives and children. By this reinforcement, Mello gained two other victories, took a great many towns, and obliged the Greeks to abandon a large territory; but, in 1019 they were utterly defeated, and every thing recovered by the Greeks. The Greek general, Bajanus, continued to go on with ſuch ſurpriſing ſucceſs, that he almoſt entirely re-eſtabliſhed the affairs of his countrymen in Italy, and made a diſtinct province of the weſtern part of Puglia, which he called *Capatanata*, and which to this day retains the name of *Capitanata*. His great progreſs at laſt alarmed the emperors of Germany; and, in 1027, Pandulphus prince of Capua made himſelf maſter of Naples; but was obliged, three years afterwards, to leave it, by the Normans, who built the city

Naples.

17 The Normans firſt known in Italy.

18 They return and defeat the Greeks.

19 But are at laſt defeated by them.

Naples. city of Averfa, which was now erected into a county. In confequence of this piece of good fortune, great numbers of Norman adventurers migrated into Italy; among whom were William, Drogo, and Umbert, three of the fons of Tancred duke of Hautville; from whofe pofterity thofe princes were defcended, who firft conquered the Ifland of Sicily from the Saracens, and formed the prefent kingdom of Naples.

In 1040, the Greek emperor Michael Paleologus, in order to fecure the affection of his fickle fubjects, undertook the conqueft of Italy from the Saracens, and for that purpofe fent a general named *Michael Maniacus* into Sicily. This commander, hearing of the great reputation of the Normans, fent to Guiamarius, prince of Salerno, intreating him to grant him fome of thofe warriors. His requeft was moft willingly hearkened to by the prince of Salerno, who, to encourage the Normans to engage in the expedition, promifed them fome additional rewards befides the emperor's pay. William, Drogo, and Umbert, accordingly marched from Salerno with 300 of their countrymen; and paffing over into Sicily, diftinguifhed themfelves moft remarkably in the conqueft of that ifland. Maniacus acknowledged, that the recovery of Meffina was chiefly owing to their valour; and William with his Normans gained a complete victory over the Saracens before Syracufe, where he killed the governor of the city in fingle combat. Maniacus made himfelf mafter of Syracufe, and almoft entirely reduced the whole ifland; but, being accufed of treafon, was next year carried prifoner to Conftantinople. His fucceffor Doceanus. being a man of no abilities, quickly loft the whole ifland except Meffina, and treated his Norman auxiliaries with the utmoft contempt. He would not allow them any fhare of the booty; and even caufed one Ardoin, a noble Lombard, and affociate and interpreter of the Normans, to be whipped round the camp, becaufe he refufed to part with the horfe of a Saracen whom he had flain in fingle combat. The confequences of this tyrannical behaviour were very fatal to the Greeks. Ardoin foon after obtained leave to return to Italy under pretence of a vow, and all the Normans embarked at night along with him; but inftead of going to Rome, Ardoin went immediately to Averfa, where he perfuaded count Rainulphus, fovereign of that province, to join with him in the defign he had formed of attacking the Greek provinces in Italy, which, he fhewed him, would be an eafy conqueft, as the inhabitants fubmitted with great reluctance to the Greeks, and the provinces were at that time almoft entirely defencelefs. Rainulphus approved of the fcheme, and raifed 300 foldiers, whom he fent under 12 officers, to join the other Normans under the fons of Tancred; and made an agreement with Ardoin, that the conquefts fhould be equally divided among the chief leaders. Their firft enterprife was the reduction of Melphis, one of the ftrongeft cities in Puglia, which prefently furrendered; and they increafed its fortifications fo much, that it thenceforth became impregnable. Soon after this they made themfelves mafters of Venofa, Afcoli, and Lavello, with very little oppofition. Doceanus alarmed with the rapidity of their conquefts, immediately left Sicily, and marched with his army into Puglia, where he attacked the invaders near the river Olivento; but, after a fierce engagement, he was obliged to retire with confiderable lofs. The Greeks were foon after defeated a fecond time at Cannæ; and in a third engagement, which happened near the river Ofanto, the army of Doceanus was entirely routed, and he himfelf obliged to fly to Bari. On this bad fuccefs Doceanus was ordered to return to his command in Sicily, and another general was fent with an army into Puglia. This new commander, however, had no better fuccefs than his predeceffor; for his army was entirely defeated in an engagement with the Normans, and he himfelf taken prifoner. Atenulphus, brother to one of the princes of Benevento, on whom the Normans had conferred the chief command, fet at liberty the captive general without confulting them, on receiving from him a confiderable fum of money. With this the Normans were fo much difpleafed, that they deprived Atenulphus of his command, and beftowed it on Argyrus fon to the late Mello, who had efcaped from Conftantinople, and now affumed the title of *duke and prince of Italy*. Before this time alfo Maniacus, whom we have formerly mentioned, had returned to Italy; and to ftrike the greater terror into the revolted cities, had executed a number of people of all ages and fexes with great inhumanity. Soon after this Maniacus openly rebelled againft the Greek emperor Conftantinus, and prevailed upon his own army to proclaim him emperor, beginning hoftilities immediately againft the Greek cities. Argyrus at the fame time took Giovennazzo and befieged Trani, and foon after befieged Maniacus himfelf in Tarento; but he, being afraid of falling into the hands of the Normans, fled to Otranto, and from thence to Bulgaria, where, being entirely defeated by one of the emperor's generals, he was taken prifoner, and had his head ftruck off.

20 The Normans pafs over into Sicily.

21 Their conquefts.

The Normans having now conquered the greateft part of Puglia, proceeded to make a divifion of their conqueft; in which, after each commander had got his proper fhare, the city of Melfis was left common to all, and appropriated as a place for affembling to confult about the moft important affairs of the nation. Argyrus alone was neglected in this divifion; but he, having gained the favour of the emperor by expelling the rebel Maniacus from Italy, was by him created duke of Bari, on purpofe to check the power of the Normans, with the title of *prince and duke of Puglia*. The Normans, however were too powerful to be much awed by Argyrus, and behaved with great infolence to the neighbouring princes; but as they could not be expelled by force, and were confirmed in their conquefts by Henry II. emperor of Germany in 1047, the Greek emperor attempted to get rid of them, by fending Argyrus with large fums of money to bribe them to enter into his fervice againft the Perfians. But they, perceiving the fnare, replied, that they were refolved not to leave Italy unlefs they were expelled by force; upon which Argyrus made ufe of the fame money in bribing the Puglians to affaffinate thefe invaders. This brought on a maffacre, in which greater numbers of Normans perifhed than had fallen in all the late wars. Argyrus attempted to take advantage of the confufion produced by this maffacre, but was defeated; after which he had recourfe to Pope Leo, befeeching him to deliver Italy from thefe cruel tyrants: but this fcheme proved ftill more unfuccefsful than the others had been; for

22 Great numbers of them maffacred.

Naples.

for the pope himself was defeated and taken prisoner, and, in consequence of the respect shewed him by the Normans, granted them, as a fief of the holy see, all the conquests they had made or should make in Calabria and Sicily.

23 They are confirmed by the pope in all their conquests.

Soon after this, the Norman power became extremely formidable; the famous Robert Guiscard ascended the throne in 1056. He made great progress in the conquest of Calabria, and reduced most of the cities which held for the Greeks in these parts. About the same time the counts of Capua were expelled from their territory; and the abbot Desiderius mentions his having seen the children of Landulphus V. the last count, going about as vagabonds, and begging for their support. The pope, alarmed by these conquests, excommunicated the Normans in wholesale, pretending that they had seized some of the territories belonging to the church; but, by the pretended submission of Robert, he not only was persuaded to take off the sentence of excommunication, but to invest him with the provinces of Apulia, Calabria, and Sicily. After this, he continued the war against the Greeks with great success. In 1071, in conjunction with his brother Roger, he conquered the island of Sicily, and gave the investiture of the whole island to him with the title of *count*, reserving to himself only the half of Palermo, Messina, and the valley of Demona. The like success attended his arms against Salerno in 1074; but after this, having unadvisedly taken some places from the pope, he again fell under the sentence of excommunication; yet he was reconciled to him in 1080, and received a second time the investiture of all his dominions. The next year he undertook an expedition against the Greeks; and though the emperor was assisted by a Venetian fleet, Robert made himself master of the island of Corfu, reduced Durazzo, and great part of Romania; insomuch that by the success of his arms, and his near approach to Constantinople, he struck an universal terror among the Greeks. But while Robert was thus extending his conquests, he was alarmed by the news of a formidable rebellion in Italy, and that the emperor Henry had taken the city of Rome, and closely shut up the pope in the castle of St Angelo. Robert therefore, leaving the command of the army to his son Boemund, returned to Italy, where he immediately dispersed the rebels, and released the pope, while his son gained a considerable victory over the Greeks. After this Robert made great preparations for another expedition into Greece, in order to second his son Boemund. Alexius, being assisted by the Venetian fleet, endeavoured to oppose his passage; but was entirely defeated, with the loss of a great many galleys. But a final stop was now put to his enterprises by his death, which happened in the island of Corfu in 1085.

24 Sicily conquered by Robert Guiscard.

Tho' the power of the Normans was thus thoroughly established in Italy and Sicily; yet by reason of the civil dissensions which took place among themselves, and the general confusion which reigned in Italy in those ages they were obliged, notwithstanding all their valour, to submit to the emperor in 1195. By him the Sicilians were treated with so great cruelty, that the empress Constantia was induced to conspire against him in 1197, took him prisoner, and released him only on condition of his sending off his army immediately for the Holy Land. This was complied with; but the emperor did not long survive the reconciliation, being poisoned, as was supposed, by order of the empress.

25 And by the emperor of Germany.

In 1254 the pope claimed the kingdom as a fief devolved on the church in consequence of a sentence of deposition pronounced against king Frederic at the council of Lyons; and, in 1263, the kingdom was, in consequence of this right, conferred on Charles count of Anjou. After much contention and bloodshed, the French thus became masters of Sicily and Naples. Their government was insupportably tyrannical; and at the same time the haughtiness of their king so provoked the pope, that he resolved to humble him. Charles had resolved on an expedition against Constantinople; and for this purpose had fitted out a fleet of 100 galleys, 30 large ships, 200 transports, besides many other smaller vessels, on board of which he intended to embark 10,000 horse, and a numerous army of foot.—This formidable armament greatly alarmed the emperor Michael Paleologus; for which reason he entered into a negociation with John di Procida, a noble Salernitan, lord of the isle of Procida in the bay of Naples, who had formed a scheme for a general revolt in the Island of Sicily. John, though a nobleman, was also a physician, and had been counsellor to two former princes, and even to king Charles himself; but being stripped of his estate by the king under pretence of treason, and his wife being debauched by the French, he retired to Constantia queen of Arragon, where he was created a baron of the kingdom of Valencia, by her husband king Peter, and Lord of Luxen, Benizzano, and Palma. As he was greatly exasperated against the French, he employed many spies both in Puglia and Sicily; and being informed that the Sicilians were totally disaffected to the French, he came to the island in disguise, and concerted a plan with the most powerful of the malcontents for a revolution in favour of Constantia, though she derived her right only as being the daughter of a former usurper named *Manfred*. Procida then set out for Constantinople, where, in some private conferences with the emperor, he persuaded him, that the most probable means of defeating Charles's scheme was by assisting the Spaniards and Sicilian malcontents. Paleologus accordingly granted him a large sum of money, and on his departure sent one of his secretaries along with him, who, landing in Sicily, had a conference with the chief conspirator. John, having received letters from them, disguised himself in the habit of a Franciscan, and went to Suriano in the neighbourhood of Rome. As he well knew the enmity which subsisted between the pope and king Charles, he disclosed his design to his holiness; who readily entered into his measures, wrote to Peter to hasten his armament, promising him the investiture of the island as soon as he had taken possession of it; and, by refusing the assistance he had promised to Charles, obliged him for the present to delay his expedition. In the beginning of the year 1280, Procida returned to Arragon; and by shewing the letters from the pope and Sicilian barons, prevailed on Peter to embark in his design, by assuring him of the assistance of Paleologus. The king of Arragon accordingly prepared a formidable fleet under pretence of invading Africa, and is even said to have received 20,000 ducats

26 The French become masters of Sicily and Naples.

cats from Charles in order to aſſiſt him in his preparations.

But while John went on thus ſucceſsfully with his ſcheme, all his meaſures were in danger of being broke by the death of pope Nicholas. The new pope, Martin IV. was entirely in the intereſt of Charles, on whom, in 1281, he conferred the ſenatorial dignity of Rome. Procida, however, ſtill reſolved to proſecute his ſcheme; and, leaving Italy, had another conference with the conſpirators in Sicily; after which, he again went to Conſtantinople, and obtained from Paleologus 30,000 ounces of gold, with which he immediately returned to Arragon. The death of Nicholas had damped the ardour of Peter; but, being urged with great earneſtneſs by John, he again renewed his preparations; which alarmed the pope and the king of France. In conſequence of this they ſent a meſſage to him, deſiring to know againſt what Saracens he deſigned to employ his armament. In this particular Peter refuſed to ſatisfy them; upon which they earneſtly counſelled Charles to guard againſt an invaſion: but he neglected their advice, being wholly intent on his eaſtern expedition, and encouraged by a revolt which had happened in Greece; and to facilitate his expedition, he prevailed on the pope to excommunicate the Greeks, on pretence that they had broken ſome of the articles of union concluded at the council of Lyons a few years before. Peter in the mean time continued his preparations with great diligence; intending to put to ſea the following ſummer. Procida had returned to
27
Palermo, to wait for a favourable opportunity of putting his deſign in execution, which was ſoon afforded

They are maſſacred.

him by the French. On Eaſter Monday, March 30th, 1282, the chief conſpirators had aſſembled at Palermo; and, after dinner, both the Palermitans and French went in a grand proceſſion to the church of Monreale, about three miles without the city. While they were ſporting in the fields, a bride happened to paſs by with her train; who being obſerved by one Drochettus, a Frenchman, he ran to her, and began to uſe her in a rude manner, under pretence of ſearching for concealed arms. A young Sicilian, exaſperated at this affront, ſtabbed him with his own ſword; and a tumult enſuing, 200 French were immediately murdered. The enraged populace then ran to the city, crying out "Let the French die, Let the French die;" and, without diſtinction of ſex or age, ſlaughtered all of that nation they could find, even ſuch as had fled to the churches. The conſpirators then left Palermo, and excited the inhabitants to murder the French all over the iſland, excepting in Meſſina, which city at firſt refuſed to be concerned in the revolt. But, being invited by the Palermitans to throw off the French yoke, a few weeks after, the citizens in a tumultuous manner deſtroyed ſome of the French; and pulling down the arms of king Charles, and erecting thoſe of the city, choſe one Baldwin for their governor, who ſaved the remaining French from the fury of the populace, and allowed them to tranſport themſelves, with their wives and children, to Italy. Eight thouſand perſons are ſaid to have been murdered on this occaſion.

Immediately after this maſſacre, the Sicilians offered their allegiance to the king of Arragon; who accepted of the invitation, and landed with his forces at Trapani. From thence he went to Palermo, where he was crowned king of Sicily with great ſolemnity, and Charles left the iſland with precipitation. The day after he landed his army in Italy, the Arragonian fleet arrived, took 29 of his galleys, and the next day burnt 80 tranſports in preſence of his army. Soon after this Charles ſent an embaſſy to Peter, accuſing him of perfidy, in invading his dominions in time of peace; and, according to ſome, challenged him at the ſame time to decide the matter by ſingle combat. Others ſay, that the challenge was given by Peter. Certain it is, however, that a challege was given, and to appearance accepted: but Peter determined to employ much more effectual means in ſupport of his pretenſions than truſting to a duel; and therefore puſhed on his operations moſt vigorouſly, while his adverſary trifled away his time: and thus he at laſt became maſter of the conteſted kingdom; which, however, he did not long enjoy, dying about the end of the year 1285.

By his will, Peter left the kingdom of Arragon to his eldeſt ſon Alphonſus, and Sicily to Don James his other ſon, who was alſo to ſucceed to the kingdom of Arragon in caſe Alphonſus ſhould die without male iſſue. Accordingly, Don James was ſolemnly crowned at Palermo the 2d of February 1286. In 1205, however, he deſerted them, and tamely reſigned up his right to Charles, ſon to him above-mentioned, in a manner perhaps unparalleled. On his reſignation the 28
Sicilians conferred the crown upon his brother Don Frederic: after which the war continued with great violence till the year 1303, when a peace was concluded, and the kingdoms of Naples and Sicily formally disjoined; Frederic being allowed to keep the latter, under the name of *Trinacria*, and Charles being confirmed in the poſſeſſion of the former, which he quietly enjoyed till his death in 1309.

The kingdoms of Naples and Sicily disjoined.

Naples continued to be governed by its own kings till the beginning of the 16th century, when the kings of France and Spain contended for the ſovereignty of this country. Frederic, at that time king of Naples, reſigned the ſovereignty to Lewis XII. on being created duke of Anjou, and receiving an annual penſion of 30,000 ducats. But, in 1504, the French were en- 29
tirely defeated by the Spaniards, and obliged to evacuate the kingdom; and the following year Lewis renounced all pretenſions to the crown, which from that time hath remained almoſt conſtantly in the hands of the Spaniards.

The Spaniards become maſters of Naples.

The government of the Spaniards proved no leſs oppreſſive to the Neapolitans than that of others had been. The kings of Spain ſet no bounds to their exactions, and of conſequence the people were loaded with all manner of taxes; even the moſt indiſpenſible neceſſaries of life not being exempted. In 1647, a new tax was laid on fruit; which the people looked upon as the moſt grievous oppreſſion; the chief part of their ſubſiſtence, during the ſummer-months, being fruit, which in the kingdom of Naples is very plentiful and delicious. The edict for collecting the new duty was 30
no ſooner publiſhed, than the people began to murmur in a tumultuous manner; and when the viceroy came abroad, they ſurrounded his coach, bawling out to have their grievances redreſſed. They were encouraged in their ſedition, by the news that the citizens of Palermo had actually revolted on account of the impoſition of new duties. The viceroy therefore, apprehenſive

A general revolt.

Naples. henfive of greater diforders, began to think of taking off the tax; but thofe who farmed the tax having bribed fome of his favourites, he was by their means perfuaded not to abolifh it. The indignation of the people, who had fufpected his intention, was now greatly increafed; efpecially as they were privately excited by feveral malcontents. The farmers of the revenue, and all thofe concerned in raifing the taxes, had incurred the hatred and deteftation of the people, particularly of Tommafo Aniello, commonly called *Maffaniello of Amalfi*, a fifherman, whofe wife, having been difcovered in fmuggling a fmall quantity of meal, was imprifoned, and condemned to pay a fine of 100 ducats.

31 Account of Maffaniello.

Maffaniello, a few years before, had come to Naples from Amalfi, where his father had been a fifherman. At this time he was about 24 years of age, and the father of four children. He was of a middling ftature, and an agreeable afpect; was diftinguifhed for his boldnefs, activity, and integrity; and had a great influence with his companions, by whom he was beloved and efteemed. As he was obliged even to fell his furniture to pay the heavy fine, he had conceived an implacable hatred againft the farmers of the taxes, and was alfo moved with compaffion for the miferable ftate of the city and kingdom. He therefore formed a defign, with fome of his companions, to raife a tumult in the market-place on the feftival-day of the Carmelites, ufually celebrated about the middle of July, when between 500 and 600 youths entertain the people by a mock-fight; one half of them in the character of Turks, defending a wooden-caftle, which is attacked and ftormed by the other half in the character of Chriftians. Maffaniello being appointed captain of one of thefe parties, and one Pione, who was privy to his defign, commanding the other, for feveral weeks before the feftival they were very diligent in reviewing and training their followers, who were armed with fticks and reeds: but a fmall and unforefeen accident tempted them to begin their enterprife without waiting for the feftival.

On the 7th of July a difpute happening in the market-place betwixt the tax-gatherers and fome gardeners of Pozzuolo who had brought fome figs into the city, whether the buyer or feller fhould pay the duty; after the tumult had continued feveral hours, Maffaniello, who was prefent with his company, excited the mob to pillage the office built in the market for receiving the duty, and to drive away the officers with ftones. The elect of the people, who, by deciding againft the gardeners, had increafed the tumult, run to the palace, and informed the viceroy, who moft imprudently neglected all means of putting a ftop to the commotion. Maffaniello, in the mean time, being joined by great numbers of people, ordered his young troop to fet fire to all the offices for the taxes through the city; which command being executed with difpatch, he then conducted them directly to the palace, where the viceroy, inftead of ordering his Spanifh and German guards to difperfe them, encouraged their infolence by timidly granting their demands. As they rufhed into the palace in a furious manner, he efcaped by a private door, and endeavoured to fave himfelf in *Caftel del Ovo;* but being overtaken by the rioters in the ftreets, he was trampled upon by them, and pulled by the hair and whifkers. However, by throwing fome handfuls of gold among them, he again efcaped, and took fanctuary in a convent of Minims, where, being joined by the archbifhop of Naples, cardinal Filomarini, and feveral nobles, by their advice he figned a billet, by which he abolifhed all taxes upon provifions. As a means to quell the tumult, he likewife defired the cardinal to offer Maffaniello a penfion of 2400 crowns, who generoufly rejected the bribe; and declared, that if the viceroy would keep his word, he would find them obedient fubjects.

It was now expected that the tumult would ceafe: but Maffaniello, upon his return to the market-place, being joined by feveral malcontents, among whom were Genuino and one Peronne, who had formerly been a captain of the Sbirri, he was advifed by them to order the houfes of thofe concerned in raifing the tax to be burned; which were accordingly in a few days reduced to afhes, with all their rich furniture. Maffaniello being now abfolute mafter of the whole city, and being joined by great numbers of people of defperate fortunes, he required the viceroy, who had retired to the *Caftel Nuovo*, to abolifh all the taxes, and to deliver up the writ of exemption granted by Charles V. This new demand greatly embarraffed the viceroy; but to appeafe the people, he drew up a falfe deed in letters of gold, and fent it to them by their favourite the duke of Matalone, who had before been in confinement. The fraud, however, being difcovered, the duke was pulled from his horfe and maltreated by the mob, and at length committed as a prifoner to Peronne. This accident, to the great joy of the viceroy, enraged the people againft the nobility, feveral of whom they killed, burnt the houfes of others, and threatened to extirpate them all. Maffaniello, in the mean time, tattered and half naked, commanded his followers, who were now well armed, and were reckoned about 100,000 men, with a moft abfolute fway. He eat and flept little, gave his orders with great precifion and judgment, appeared full of moderation, without ambition and interefted views. But the duke of Matalone having procured his liberty by bribing Peronne, the viceroy imitated his example, and fecretly corrupted Genuino to betray his chief. A confpiracy was accordingly formed againft Maffaniello by Matalone and Peronne; the duke, who was equally exafperated againft the viceroy, propofing, that after his death his brother D. Jofeph fhould head the rebels.

Maffaniello in the mean time, by means of the cardinal archbifhop, was negociating a general peace and accommodation; but while both parties were affembling in the convent of the Carmelites, the banditti hired by Matalone made an unfuccefsful attempt upon Maffaniello's life. His followers immediately killed 150 of them. Peronne and D Jofeph being difcovered to be concerned in the confpiracy, were likewife put to death, and the duke with great difficulty efcaped. Maffaniello by this confpiracy was rendered more fufpicious and fevere. He began to abufe his power by putting feveral perfons to death upon flight pretences; and, to force the viceroy to an accommodation, he cut off all communication with the caftles, which were unprovided with provifion and ammunition. The viceroy likewife being afraid left the French fhould take advantage of the commotion, earneftly defired to agree to a treaty; which was accordingly concluded on

Naples. on the fifth day of the inſurrection, by the mediation of the archbiſhop. By the treaty it was ſtipulated,
32 A treaty concluded between Maſſanielio and the viceroy. that all duties impoſed ſince the time of Charles V. ſhould be aboliſhed; that the writ of exemption granted by that emperor ſhould be delivered to the people; that for the future no new taxes ſhould be impoſed; that the vote of the elect of the people ſhould be equal to the votes of the nobility; that an act of oblivion ſhould be granted for all that was paſt; and that the people ſhould continue in arms under Maſſaniello till the ratification of the treaty by the king.

By this treaty, no leſs than 10,000 perſons, who fattened upon the blood of the public, were ruined. The people, when it was ſolemnly publiſhed, manifeſted an extreme joy, believing they had now recovered all their ancient rights and privileges. Maſſaniello, at the deſire of the viceroy, went to the palace to viſit him, accompanied by the archbiſhop, who was obliged to threaten him with excommunication, before he would conſent to lay aſide his rags and aſſume a magnificent dreſs. He was received by the duke with the greateſt demonſtrations of reſpect and friendſhip, while the ducheſs entertained his wife, and preſented her with a robe of cloth of ſilver, and ſome jewels. The viceroy,
33 Maſſaniello appointed captain-general. to preſerve ſome ſhadow of authority, appointed him captain-general; and at his departure made him a preſent of a golden chain of great value, which with great difficulty he was prevailed upon to accept; but yielded at length to the intreaties of the cardinal. Next day, in conſequence of the commiſſion granted him by the viceroy, he began to exerciſe all the functions of ſovereign authority; and having cauſed a ſcaffold to be erected in one of the ſtreets, and ſeveral gibbets, he judged all crimes, whether civil or military, in the laſt reſort; and ordered the guilty to be immediately put to death, which was the puniſhment he aſſigned to all offences. Though he neglected all forms of law, and even frequently judged by phyſiognomy, yet he is ſaid not to have overlooked any criminal, or puniſhed any innocent perſon.

His grandeur and proſperity was of very ſhort continuance: for his mind becoming diſtracted and deliri-
34 Is aſſaſſinated. ous for two or three days, he committed a great many mad and extravagant actions; and on the 18th of July was aſſaſſinated with the conſent of the viceroy.

The tumult did not end with the death of Maſſaniello: on the contrary, the people now expelled the Spaniards from moſt of the cities throughout the kingdom; and this general inſurrection being the ſubject of diſcourſe at Rome, the duke of Guiſe, who happened then to be at the pope's court, took the opportunity, at the inſtigation of his holineſs, to offer his ſervice to the Neapolitans againſt the Spaniards. The duke was prompted by his ambition to engage in this enterpriſe, eſpecially as he himſelf had ſome diſtant pretenſions to the crown. The Spaniards in the mean time made a vigorous attack on the city; but were repulſed by the people, who now formally renounced their allegiance to them. In a ſhort time, however, their city being ſurpriſed by the new viceroy the count d'Oniate, and the duke of Guiſe himſelf taken priſon-
35 The people return to their allegiance. er, the people returned to their allegiance: and thus all the attempts of the French on Naples were fruſtrated. Since that time the Spaniards continued in peaceable poſſeſſion of the kingdom till the year 1707, when it was taken from them by prince Eugene. It was formally ceded to the emperor by the treaty of Raſtadt in 1713; but was recovered by the Spaniards in 1734, and the king of Spain's eldeſt ſon is now the king of Naples and Sicily. For a particular account of theſe revolutions, ſee the articles SPAIN and SICILY.

The climate of Naples is extremely hot, eſpecially in July, Auguſt, and September. In winter there is ſeldom any ice or ſnow, except on the mountains. On account of its fertility, it is juſtly termed an earthly paradiſe; for it abounds with all ſorts of grain, the fineſt fruit and garden-productions of every kind, with rice, flax, oil, and wine, in the greateſt plenty and perfection. It affords alſo ſaffron, manna, alum, vitriol, ſulphur, rock-cryſtal, marble, and ſeveral ſorts of minerals, together with fine wool, and ſilk. The horſes of this country are famous, and the flocks and herds very numerous. Beſides theſe products, of which a conſiderable part is exported, there are manufactures of ſnuff, ſoap, and glaſs-ware. Waiſtcoats, caps, ſtockings, and gloves, are alſo made of the hair or filaments of a ſhell-fiſh, which are warmer than thoſe of wool, and of a beautiful gloſſy green. In this kingdom likewiſe is found that called the *Phrygian ſtone*, or *pietra fungifera*, which, being laid in a damp ſhady place, will yield muſhrooms, ſometimes of a very large ſize, eſpecially if the ſtone is ſprinkled with hot water. See AGARICUS. 36 Climate, produce, &c. of Naples.

As to the mountains of this country, the principal are thoſe of the Apennine, which traverſe it from ſouth to north; and Mount Veſuvius, which, as is well known, is a noted volcano, five Italian miles from Naples. The ſide of this mountain next the ſea yields wine, particularly the two famed wines called *Vino Greco* and *Lachrymæ Chriſti*. One of the greateſt inconveniencies to which this kingdom is expoſed is earthquakes, which the eruptions of Mount Veſuvius contribute, in ſome meaſure, to prevent. Another inconveniency, which, however, is common to it with other hot countries, is the great number of reptiles and inſects, of which ſome are very poiſonous.

With reſpect to religion, it is on a very bad footing here. The number of convents and monaſteries is aſtoniſhing. It is ſaid, the clergy and convents poſſeſs two-thirds of the whole kingdom: nay, ſome maintain, that were the kingdom divided into five parts, four would be found in the hands of the church. Notwithſtanding this power and influence of the clergy, they have not been able hitherto to get the inquiſition eſtabliſhed here. In the year 1731, meaſures were taken for leſſening the number of convents; and, lately, the order of Jeſuits hath been ſuppreſſed. The papal bulls cannot be made public without the king's permiſſion; nor are proteſtants compelled to kneel in the churches, or at the meeting the hoſt; and in Lent they can very eaſily procure fleſh-meat. In the year 1740, the Jews were allowed to ſettle in the kingdom, during the term of 50 years, and ſeveral privileges were granted them during that period; at the expiration of which, the grant was to be ſuppoſed to be renewed, unleſs they were expreſsly ordered to quit the country. 37 Religion.

The revenue of the kingdom is generally computed at 3,000,000 of crowns; but, as Mr Addiſon obſerves, there is no country in Europe which pays 38 Revenue, &c.

Naples.

greater taxes, and where, at the same time, the public is less the better for them, most of them going to the enriching of the private persons to whom they are mortgaged.

The military force of this kingdom is said to consist of about 30,000 men, of which the Swiss regiments are the best. As to the marine, it consists only of a few galleys. The only order here is that of St Januarius, which was instituted by Don Carlos, in the year 1738.

The king of Naples, or of the two Sicilies, is an hereditary monarch. The high colleges are the council of state, the privy-council, the treasury, the Sicily-council, the council of war, &c. This kingdom is a papal fief; and the king, in acknowledgment of the pope's feudal right, sends him every year a white palfry, and a purse of 6000 ducats. The title of the king's eldest son is *prince of Calabria*. The number both of the high and low nobility in the kingdom of Naples is very great; but their incomes in general are very slender. The higher nobles consist of princes, dukes, marquisses, and barons. The general assembly of the states, consisting of the nobility and commons, is summoned, every two years, to meet at the capital, to deliberate on the customary free gift to the crown.

The inhabitants of this country bear but an indifferent character among other nations; but if they are really as defective in this respect as they are represented, it is undoubtedly, in some measure at least, owing to the oppression and slavery under which they groan, both from their civil and ecclesiastic governors. The kingdom is divided into twelve provinces or jurisdictions.

Naples, anciently *Parthenope*, afterwards *Neapolis*, the capital of the kingdom of that name in Italy, lying in the province called *Terra di Lavora*, which is the richest and best inhabited of the whole kingdom, and comprehends a part of the ancient Campania Felix, or the Happy. This city is said to be the first for strength and neatness, and the third for bigness, in all Italy. It is most advantageously situated, having a delicious country on one side, and a noble bay of the Mediterranean on the other, with an excellent harbour. The circumference, including the suburbs, is said not to be less than 18 Italian miles, and the number of the inhabitants therein above 400,000. The houses are of stone, flat-roofed, and generally lofty and uniform; but many of them have balconies, with lattice-windows. The streets are well paved; but they are not lighted at night, and in the day-time are disfigured, in many places, by stalls, on which provisions are exposed to sale. Here are a great number of fine churches, convents, fountains, and palaces of the nobility, many of whom constantly reside here. It is usual to walk on the tops of the houses in the evenings, to breathe the sweet cool air, after a hot sultry day. The climate here is so mild and warm, even in the winter, that plenty of green pease, artichokes, asparagus, and other vegetables, may be had so early as the beginning of the new year, and even all the winter. This city swarms with monks and nuns of all sorts, to such a degree, that there are no less than 19 convents of the Dominicans alone, 18 of the Franciscans, 8 of the Augustines, and in proportion of the rest. The magnificence of many of the churches exceeds imagination. In a cloyster of the Carthusian monastery is a crucifix, said to be done by Michael Angelo, of inimitable workmanship. The fortifications of Naples are very strong, both towards the land and the sea, there being no less than five castles: yet the city is far from being secure from a bombardment; for the sea is so deep, that a large vessel may come up to the very mole, and there is nothing to prevent an enemy's approaches on that side, but a few galleys, the mole, and two small castles. Pictures, statues, and antiquities, are not so common in Naples, as might be expected in so great and ancient a city, many of the most valuable pieces having been sent to Spain by the viceroys. The bay is one of the finest in the world, being almost of a round figure, of about 30 miles in the diameter, and three parts of it sheltered with a noble circuit of woods and mountains. The city stands in the bosom of this bay, in as pleasant a situation, perhaps, as in the world. Mr Keysler says, they reckon about 18000 donne libere, or courtezans, in the city. Though the common people are generally so lazy as to prefer beggary or robbing to labour; yet there are some flourishing manufactures here, and a brisk trade. The city is supplied with a vast quantity of water, by means of a very costly aqueduct, from the foot of Mount Vesuvius. Mr Addison says, it is incredible how great a multitude of retainers to the law there are in Naples, who find continual employment from the fiery temper of the inhabitants. There are five piazzas or squares in the city, appropriated to the nobility, viz. those called *Capuana*, *Nido*, *Montagna*, *Porto*, and *Porta Nova*. Of all the palaces, that of the king is not only the most magnificent, but also in the best style of architecture. The cathedral, though Gothic, is a very grand splendid edifice. It is here that the head and blood of St Januarius, the tutelary saint of Naples, are kept, the latter in two glass or crystal vials. The pretended liquefaction of the dried blood, as soon as brought near the head of the saint, is a thing well known; Mr Addison says, it is one of the most bungling tricks he ever saw *. The harbour is spacious, and kept in good repair. It is fortified with a mole, which runs above a quarter of a mile into the sea, and at the extremity has a high lantern to direct ships safely into the harbour. Luxury here is restrained by severe sumptuary laws, and the women are more closely confined than in any other city of Italy. Here is an university and two academies of wits, the one called *Gli Ardenti*, and the other *Gli Otiosi*. The nunnery for ladies of quality is said to be the largest in the whole world, containing no less than 350 nuns, besides servants. The Mount of Piety, or the office for advancing money to the poor, on pledges, at a low interest, or without any, has an income of upwards of 50000 ducats. The arsenal is said to contain arms for 50000 men. The walls of the city consist of hard black quarry stones, called *piperno*.—Instead of ice, vast quantities of snow are used for cooling their liquors, not so much as water being drank without it; so that, it is said, a scarcity of it would as soon occasion a mutiny as a dearth of corn or provisions. Certain persons, who farm the monopoly of it from the government, supply the city all the year round from

* See *Chemistry*, nº 237.

from a mountain about 18 miles off, at so much the pound. Naples stands 110 miles south-east from Rome, 164 north-east from Palermo in Sicily, 217 south-east from Florence, and 300 from Venice. E. Long. 14. 20. N. Lat. 40. 55.

NARBO, (anc. geog.) a town of the Volcæ Tectosages, called also *Narbo Martius*, from the Legio Martia, the colony led thither 59 years before the consulate of Cæsar, (Velleius); increased with a colony of the Decumani or tenth legion by Cæsar. An ancient trading town on the Atax, which discharges itself into the sea through the Lacus Rubresus, or Rubrensis. Capital of the Gallia Narbonensis; surnamed *Colonia Julia Paterna*, from Julius Cæsar, the father of Augustus by adoption. Now called *Narbonne*, a city of Languedoc.

NARBONNE, an ancient and large city of France, in Lower Languedoc, with an archbiship's see, and famous for its honey. It is seated on a canal cut from the river Aude, which being but three miles from the sea, vessels come up it laden with merchandise, which renders it a place of great trade. It is very ancient, being built in the time of the Romans; and the ruins of a capitol, an amphitheatre, and several other buildings, still remain. It is divided into the city and the town, which are joined together by a bridge, with houses on each side, in which the richest merchants live. There are several churches and convents, and the metropolitan church has a handsome steeple. E. Long. 2. 6. N. Lat. 43. 11.

NARCISSUS, in fabulous history, the son of the river Cephissus and Liriope, the daughter of Oceanus, was a youth of great beauty. Tiresias foretold that he should live till he saw himself. He despised all the nymphs of the country; and made Echo languish till she became a mere sound, by refusing to return her passion: but one day coming weary and fatigued from the chace, he stopped on the bank of a fountain to quench his thirst; when, seeing his own form in the water, he became so in love with the shadowy image, that he languished till he died. On which the gods, being moved at his death, changed him into the flower which bears his name.

NARCISSUS, a genus of the monogynia order, belonging to the hexandria class of plants. The most remarkable species are,

1. The bastard narcissus, or common yellow English daffodil, grows wild in great plenty in many of our woods and coppices, and under hedges in several parts of England. In the counties round London the herbfolks bring prodigious quantities in the spring of the year, when in bloom, root and all, and sell them about the streets. Its commonness renders it of but little esteem with many; considered, however, as an early and elegant flower, of exceeding hardiness and easy culture, it merits a place in every garden.

2. The bicolor, or two-coloured incomparable narcissus, hath a large, oblong, bulbous root; crowned with long, narrow, dark-green leaves, 12 or 14 inches long; an upright flower-stalk, about 15 inches high, terminated by an uniflorous spatha, protruding one large flower with white petals, and a bell-shaped, spreading, golden nectarium, waved on the margin, and equal in length with the corolla; flowering in April. The varieties are, common single-flowered—semi-double-flowered, with the interior petals some white, and some yellow——with sulphur-coloured flowers.

3. The poeticus, poetic daffodil, or common white narcissus, is well known. Of this there are varieties with purple-cupped flowers—yellow-cupped flowers—double-flowered: all of them with entire white petals. It is the ancient celebrated narcissus of the Greek and Roman poets, which they so greatly extol for its extreme beauty and fragrance.

4. The bulbocodium, hath a small bulbous root, crowned with several narrow, subulate, rush-like leaves, six or eight inches long; amidst them a slender, taper flower-stalk, six inches high, terminated by an uniflorous spatha, protruding one yellow flower, having the nectarium much larger than the petals, and very broad and spreading at the brim; flowering in April. From the large spreading nectarium of this species, which being three or four times longer than the petals, narrow at bottom, and widening gradually to the brim, so as to resemble the shape of some old-fashioned hoop-petticoats, it obtained the name *hoop-petticoat narcissus*.

5. The serotinus, or late-flowering small autumnal narcissus, hath a small bulbous root; crowned with a few narrow leaves; amidst them a jointed flower-stalk, eight or nine inches high, trrminated by an uniflorous spatha, protruding one white flower, having a short, six-parted, yellow nectarium; flowering in autumn.

6. The tazetta, or multiflorous daffodil, commonly called *polyanthus narcissus*, hath a very large, roundish, bulbous root; long, narrow, plane leaves; an upright flower-stalk, rising from 10 or 12 inches to a foot and a half high; terminated by a multiflorous spatha, protruding many large, spreading, white and yellow flowers, in a cluster, having bell-shaped nectariums shorter than the corolla; flowering in February, March, and April, and is very fragrant. The varieties of this are very numerous, consisting of about eight or nine principal sorts, each of which having many intermediate varieties; amounting in the whole greatly above an hundred in the Dutch florists catalogues, each variety distinguished by a name according to the fancy of the first raiser of it. They are all very pretty flowers, and make a charming appearance in the flower-borders, &c. they are also finely adapted for blowing in glasses of water, or in pots, to ornament rooms in winter.

7. The jonquilla, or jonquil, sometimes called *rush-leaved daffodil*, hath an oblong, bulbous, brown root; sending up several long, semi-taper, rush-like, bright-green leaves; amidst them an upright green flower-stalk, a foot or 15 inches high; terminated by a multiflorous spatha, protruding many yellow flowers, often expanded like a radius, each having a hemispherical, crenated nectarium, shorter than the petals; flowering in April, and mostly of a fine fragrance. The varieties are, Jonquil minor with single flowers—jonquil major with single flowers—starry flowered—yellow and white flowered—white-flowered—semi-double-flowered—double-flowered—and large double inodorous jonquil: all of them multiflorous, the singles in particular; but sometimes the doubles produce only two or three flowers from a spatha, and the singles commonly six or eight. All the sorts have so fine a

fhape, fo foft a colour, and fo fweet a fcent, that they are fome of the moft agreeable fpring-flowers.

8. The calathinus, or multiflorous yellow narciffus, hath a large bulbous root; crowned with long, narrow, plane leaves; and amidft them an erect, robuft flower-ftalk, terminated by a multiflorous fpatha, protruding many large, entire, yellow flowers having a bell-fhaped, flightly crenated nectarium, equal in length with the petals.

9. The odorus, odoriferous or fweet-fcented ftarry yellow narciffus, hath a bulbous root; narrow leaves; erect flower-ftalk, a foot or more high, terminated by a fub-multiflorous fpatha, protruding fometimes but one, and fometimes feveral entirely yellow flowers, having a companulated, fix-parted, fmooth nectarium, half the length of the petals.

10. The triandrus, or triandrous rufh-leaved white narciffus, hath a bulbous root; very narrow, rufh-like leaves; erect flower-ftalk, terminated by an uniflorous fpatha, protruding one fnowy-white flower, having a bell-fhaped, crenated nectarium, half the length of the petals, and with moftly triandrous or three ftamina.

11. The trilobus, or trilobate yellow narciffus, hath a bulbous root; narrow rufh-like leaves; erect flower-ftalks, terminated by a fub-multiflorous fpatha, protruding fometimes but one or two, and fometimes feveral, yellow flowers, having a bell-fhaped, three-lobed nectarium, half the length of the petals.

12. The minor, or yellow winter daffodil, hath a fmall bulbous root; plane leaves, eight or ten inches long, and more than half a one broad; an erect flower-ftalk, terminated by an uniflorous fpatha, portruding one nodding yellow flower, with fpear-fhaped petals, having an obconic, fix-parted, waved nectarium, equal to the length of the corolla; flowering in winter, or very early in fpring.

All thefe 12 fpecies of narciffus are of the bulbous-rooted tribe, and univerfally perennial in root, but annual in leaf and flower-ftalk; all of them rifing annually in fpring, immediately from the crown of the bulb, firft the leaves, and in the midft of them the flower-ftalk, one only from each root, entirely naked or leaflefs, each terminated by a fpatha or fheath, which opens on one fide to protrude the flowers, and then withers; the flowers, as before obferved, are all hexapetalous, each furnifhed with a nectarium in the centre, and are univerfally hermaphrodite: they are large and confpicuous, appearing moftly in the fpring-feafon, generally from March or April until June, fucceeded by ripe feed in July; then the leaves and flower-ftalks decay, and the roots defift from growing for fome time; at which period of reft is the only proper time to take up or tranfplant the roots from one place to another, or to feparate the offsets; for they all multiply abundantly by offset young bulbs from the main root, infomuch that a fingle bulb will in one or two years be increafed into a large clufter of feveral bulbs, clofely placed together, and which every fecond or third year fhould be taken up at the above period in order to be feparated; and each offset fo feparated commences a diftinct plant, which being planted again in autumn, produces flowers the following fummer, alike in every refpect to thofe of their refpective parent-bulbs. All the fpecies are fo hardy that they profper in any common foil of a garden: obferving, however, to allow the finer forts of *polyanthos narciffus*, in particular, principally a warm dry fituation; all the others may be planted any where in the open dry borders and flower-beds.

NARCOTICS, in medicine, foporiferous drugs, which bring on a ftupefaction. Among narcotics the moft eminent are thofe ufually prepared for medicinal ufes of the whole poppy, efpecially opium; as alfo all thofe prepared of mandragoras, hyofciamus, ftramonium, and datura.

NARDO, a pretty populous town in the kingdom of Naples, and in the Terra d'Otranto, with the title of a duchy and a bifhop's fee. E. Long. 18. 27. N. Lat. 43. 28.

NARRATION, in oratory, poetry, and hiftory, a recital or rehearfal of a fact as it happened, or when it is fuppofed to have happened. See ORATORY, n° 26. 123.

Concerning NARRATION *and Defcription*, we have the following rules and obfervations in the Elements of Criticifm.

1. The firft rule is, That in hiftory the reflections ought to be chafte and folid; for while the mind is intent upon truth, it is little difpofed to the operations of the imagination. Strada's Belgic hiftory is full of poetical images, which, being difcordant with the fubject, are unpleafant; and they have a ftill worfe effect, by giving an air of fiction to a genuine hiftory. Such flowers ought to be fcattered with a fparing hand, even in epic poetry; and at no rate are they proper, till the reader be warmed, and by an enlivened imagination be prepared to relifh them: in that ftate of mind, they are agreeable; but while we are fedate and attentive to an hiftorical chain of facts, we reject with difdain every fiction.

2. Vida, following Horace, recommends a modeft commencement of an epic poem; giving for a reafon, That the writer ought to hufband his fire. Befides, bold thoughts and figures are never relifhed till the mind be heated and thoroughly engaged, which is not the reader's cafe at the commencement. Homer introduces not a fingle fimile in the firft book of the Iliad, nor in the firft book of the Odyffey. On the other hand, Shakefpeare begins one of his plays with a fentiment too bold for the moft heated imagination:

Bedford. Hung be the heav'ns with black, yield day
to night!
Comets, importing change of times and ftates,
Brandifh your cryftal treffes in the fky,
And with them fcourge the bad revolting ftars,
That have confented unto Henry's death!
Henry the Fifth, too famous to live long!
England ne'er loft a king of fo much worth.

Firft part Henry VI.

The paffage with which Strada begins his hiftory, is too poetical for a fubject of that kind; and at any rate too high for the beginning of a grave performance.

3. A third rule or obfervation is, That where the fubject is intended for entertainment folely, not for inftruction, a thing ought to be defcribed as it appears, not as it is in reality. In running, for example, the impulfe upon the ground is proportioned in fome de-

gree to the celerity of motion; though in appearance it is otherwife, for a perfon in fwift motion feems to fkim the ground, and fcarcely to touch it. Virgil, with great tafte, defcribes quick running according to appearance; and raifes an image far more lively, than by adhering fcrupuloufly to truth:

Hos fuper advenit Volfca de gente Camilla,
Agmen agens equitum et florentes ære catervas,
Bellatrix: non illa colo calathifve Minervæ
Fœmineas affueta manus; fed prælia virgo
Dura pati, curfuque pedum prævertere ventos.
Illa vel intactæ fegetis per fumma volaret
Gramina: nec teneras curfu læfiffet ariftas:
Vel mare per medium, fluctu fufpenfa tumenti,
Ferret iter; celeres nec tingeret æquore plantas.

Æneid. vii. 803.

4. In narration as well as in defcription, objects ought to be painted fo accurately as to form in the mind of the reader diftinct and lively images. Every ufelefs circumftance ought indeed to be fuppreffed, becaufe every fuch circumftance loads the narration; but if a circumftance be neceffary, however flight, it cannot be defcribed too minutely. The force of language confifts in raifing complete images; which have the effect to tranfport the reader as by magic into the very place of the important action, and to convert him as it were into a fpectator, beholding every thing that paffes. The narrative in an epic poem ought to rival a picture in the livelinefs and accuracy of its reprefentations: no circumftance muft be omitted that tends to make a complete image; becaufe an imperfect image, as well as any other imperfect conception, is cold and uninterefting. We fhall illuftrate this rule by feveral examples, giving the firft place to a beautiful paffage from Virgil:

Qualis *populeâ* mœrens Philomela fub umbrâ
Amiffos queritur fœtus, quos durus *arator*
Obfervans nido *implumes* detraxit.

Georg. lib. 4. *l.* 511.

The poplar, plowman, and unfledged young, though not effential in the defcription, tend to make a complete image, and upon that account are an embellifhment.

Again:

Hic viridem Æneas *frondenti ex ilice* metam
Conftituit, fignum nautis. *Æneid.* v. 129.

Horace addreffing to fortune:

Te pauper ambit follicita prece
Ruris colonus: te dominam æquoris,
Quicumque Bithynâ laceffit
Carpathium pelagus carinâ.

Carm. lib. 1. *ode* 35.

—— Illum ex mœnibus hofticis
Matrona bellantis tyranni
Profpiciens, et adulta virgo,
Sufpiret: Eheu, ne rudis agminum
Sponfus laceffat regius afperum
Tactu leonem, quem cruenta
Per medias rapit ira cædes.

Carm. lib. 3. *ode* 2.

Shakefpear fays, "You may as well go about to turn the fun to ice by fanning in his face with a *peacock's* feather." The peacock's feather, not to mention the beauty of the object, completes the image: an accurate image cannot be formed of that fanciful operation, without conceiving a particular feather; and one is at a lofs when this is neglected in the defcription. Again, "The rogues flighted me into the river with as little remorfe, as they would have drown'd a bitch's blind puppies, fifteen i' th' litter."

Old Lady. You would not be a queen?
Anne. No, not for all the riches under heaven.
Old Lady. 'Tis ftrange: a three-pence bow'd would hire me, old as I am, to queen it.

Henry VIII. act. 2. *fc.* 5.

In the following paffage, the action, with all its material circumftances, is reprefented fo much to the life, that it would fcarce appear more diftinct to a real fpectator; and it is the manner of defcription that contributes greatly to the fublimity of the paffage.

He fpake; and to confirm his words, out-flew
Millions of flaming fwords, drawn from the thighs
Of mighty cherubim; the fudden blaze
Far round illumin'd hell: highly they rag'd
Againft the Higheft, and fierce with grafped arms,
Clafh'd on their founding fhields the din of war,
Hurling defiance toward the vault of heav'n.

Milton, b. 1.

The following paffage from Shakefpeare falls not much fhort of that now mentioned in particularity of defcription:

O you hard hearts! you cruel men of Rome!
Knew you not Pompey? Many a time and oft
Have you climb'd up to walls and battlements,
To tow'rs and windows, yea, to chimney-tops,
Your infants in your arms; and there have fat
The live-long day with patient expectation
To fee great Pompey pafs the ftreets of Rome;
And when you faw his chariot but appear,
Have you not made an univerfal fhout,
That Tyber trembled underneath his banks,
To hear the replication of your founds,
Made in his concave fhores?

Julius Cæfar, act 1. *fc.* 1.

The following paffage is fcarce inferior to either of thofe mentioned:

"Far before the reft, the fon of Offian comes; bright in the fmiles of youth, fair as the firft beams of the fun. His long hair waves on his back: his dark brow is half beneath his helmet. The fword hangs loofe on the hero's fide; and his fpear glitters as he moves. I fled from his terrible eye, King of high Temora." *Fingal.*

The Henriade of Voltaire errs greatly againft the foregoing rule: every incident is touched in a fummary way, without ever defcending to circumftances. This manner is good in a general hiftory, the purpofe of which is to record important tranfactions: but in a fable it is cold and uninterefting; becaufe it is impracticable to form diftinct images of perfons or things reprefented in a manner fo fuperficial.

It is obferved above, that every ufelefs circumftance ought to be fuppreffed. The crowding fuch circumftances is, on the one hand, not lefs to be avoided, than the concifenefs for which Voltaire is blamed, on the other. In the Æneid, Barce, the nurfe of Sichæus,

Narration. chæus, whom we never hear of before nor after, is introduced for a purpose not more important than to call Anna to her sister Dido: and that it might not be thought unjust in Dido, even in this trivial circumstance, to prefer her husband's nurse before her own, the poet takes care to inform his reader, that Dido's nurse was dead. To this may be opposed a beautiful passage in the same book, where, after Dido's last speech, the poet, without detaining his readers by describing the manner of her death, hastens to the lamentation of her attendants:

Dixerat: atque illam media inter talia ferro
Collapsam aspiciunt comites, ensemque cruore
Spumantem, sparsasque manus. It clamor ad alta
Atria, concussam bacchatur fama per urbem;
Lamentis gemituque et fœmineo ululatu
Tecta fremunt, resonat magnis plangoribus æther.
Lib. 4. l. 663.

As an appendix to the foregoing rule, may be added the following observation, That to make a sudden and strong impression, some single circumstance, happily selected, has more power than the most laboured description. Macbeth, mentioning to his lady some voices he heard while he was murdering the King, says,

There's one did laugh in sleep, and one cry'd Murder!
They wak'd each other; and I stood and heard them;
But they did say their prayers, and address them
Again to sleep.
Lady. There are two lodg'd together.
Macbeth. One cry'd, God bless us! and, Amen! the other;
As they had seen me with these hangman's hands.
Listening their fear, I could not say, Amen,
When they did say, God bless us.
Lady. Consider it not so deeply.
Macbeth. But wherefore could not I pronounce Amen?
I had most need of blessing, and Amen
Stuck in my throat.
Lady. These deeds must not be thought
After these ways; so, it will make us mad.
Macbeth. Methought, I heard a voice cry, Sleep no more!
Macbeth doth murder sleep, &c. *Act* 2. *sc.* 3.

Describing prince Henry:

I saw young Harry, with his beaver on,
His cuisses on his thighs, gallantly arm'd,
Rise from the ground like feather'd Mercury;
And vaulted with such ease into his seat,
As if an angel dropt down from the clouds,
To turn and wind a fiery Pegasus,
And witch the world with noble horsemanship.
First part Henry IV. *act* 4. *sc.* 2.

King Henry. Lord Cardinal, if thou think'st on Heaven's bliss,
Hold up thy hand, make signal of thy hope.
He dies, and makes no sign!
Second part Henry VI. *act* 3. *sc.* 10.

The same author, speaking ludicrously of an army debilitated with diseases, says,

" Half of them dare not shake the snow from off their cassocks, lest they shake themselves to pieces."

" I have seen the walls of Balclutha, but they were desolate. The flames had resounded in the halls: and the voice of the people is heard no more. The stream of Clutha was removed from its place by the fall of the walls. The thistle shook there its lonely head: the moss whistled to the wind. The fox looked out from the windows: and the rank grass of the wall waved round his head. Desolate is the dwelling of Morna: silence is in the house of her fathers." *Fingal.*

To draw a character is the master-stroke of description. In this Tacitus excels: his portraits are natural and lively, not a feature wanting or misplaced. Shakespeare, however, exceeds Tacitus in liveliness; some characteristical circumstance being generally invented or laid hold of, which paints more to the life than many words. The following instances will explain our meaning, and at the same time prove our observation to be just.

Why should a man, whose blood is warm within,
Sit like his grandsire cut in alabaster?
Sleep when he wakes, and creep into the jaundice,
By being peevish? I tell thee what, Anthonio,
(I love thee, and it is my love that speaks),
There are a sort of men, whose visages
Do cream and mantle like a standing pond;
And do a wilful stillness entertain,
With purpose to be dress'd in an opinion
Of wisdom, gravity, profound conceit;
As who should say, I am Sir Oracle,
And when I ope my lips, let no dog bark!
O my Anthonio! I do know of those,
That therefore only are reputed wise,
For saying nothing.
Merchant of Venice, *act.* 1. *sc.* 2.

Again:

" Gratiano speaks an infinite deal of nothing, more than any man in all Venice: his reasons are two grains of wheat hid in two bushels of chaff; you shall seek all day ere you find them; and when you have them, they are not worth the search." *Ibid.*

In the following passage, a character is completed by a single stroke:

Shallow. O the mad days that I have spent; and to see how many of mine old acquaintance are dead.

Silence. We shall all follow, cousin.

Shallow. Certain, 'tis certain, very sure, very sure; Death (as the Psalmist saith) is certain to all: all shall die. How a good yoke of bullocks at Stamford fair?

Slender. Truly, cousin, I was not there.

Shallow. Death is certain. Is old *Double* of your town living yet?

Silence. Dead, Sir.

Shallow. Dead! see, see; he drew a good bow: and dead. He shot a fine shoot. How a score of ewes now?

Silence. Thereafter as they be. A score of good ewes may be worth ten pounds.

Shallow. And is old *Double* dead?
Second part Henry IV. *act.* 3. *sc.* 3.

Describing a jealous husband:

" Neither press, coffer, chest, trunk, well, vault, but he hath an abstract for the remembrance of such places, and goes to them by his note. There is no hiding you in the house." *Merry Wives of Windsor*, *act* 4. *sc.* 3.

Congreve

Narration. Congreve has an inimitable ftroke of this kind in his comedy of *Love for Love:*

Ben Legend. Well, father, and how do all at home? how does brother Dick, and brother Val?

Sir Sampfon. Dick, body o' me, Dick has been dead thefe two years. I writ you word when you were at Leghorn.

Ben. Mefs, that's true; marry, I had forgot. Dick's dead, as you fay. *Act* 3. *fc.* 6.

Falftaff fpeaking of Ancient Piftol:

" He's no fwaggerer, hoftefs; a tame cheater i'faith; you may ftroak him as gently as a puppy-greyhound; he will not fwagger with a Barbary hen, if her feathers turn back in any fhew of refiftance."

Second part Henry IV. *act* 2. *fc.* 9.

Offian among his other excellencies is eminently fuccefsful in drawing characters; and he never fails to delight his reader with the beautiful attitudes of his heroes. Take the following inftances:

" O Ofcar! bend the ftrong in arm; but fpare the feeble hand. Be thou a ftream of many tides againft the foes of thy people; but like the gale that moves the grafs to thofe who afk thine aid.—So Tremor lived; fuch Trathal was; and fuch has Fingal been. My arm was the fupport of the injured; and the weak refted behind the lightning of my fteel."

" We heard the voice of joy on the coaft, and we thought that the mighty Cathmor came. Cathmor the friend of ftrangers! the brother of red-haired Cairbar! But their fouls were not the fame; for the light of heaven was in the bofom of Cathmor. His towers rofe on the banks of Atha: feven paths led to his halls: feven chiefs ftood on thefe paths, and called the ftranger to the feaft. But Cathmor dwelt in the wood to avoid the voice of praife."

" Dermid and Ofcar were one: they reaped the battle together. Their friendfhip was ftrong as their fteel; and death walked between them to the field. They rufh on the foe like two rocks falling from the brow of Ardven. Their fwords are ftained with the blood of the valiant: warriors faint at their name. Who is equal to Ofcar but Dermid? who to Dermid but Ofcar?"

" Son of Comhal, replied the chief, the ftrength of Morni's arm has failed: I attempt to draw the fword of my youth, but it remains in its place: I throw the fpear, but it falls fhort of the mark: and I feel the weight of my fhield. We decay like the grafs of the mountain, and our ftrength returns no more. I have a fon, O Fingal! his foul has delighted in the actions of Morni's youth; but his fword has not been fitted againft the foe, neither has his fame begun. I come with him to battle, to direct his arm. His renown will be a fun to my foul, in the dark hour of my departure. O that the name of *Morni* were forgot among the people! that the heroes would only fay, *Behold the father of Gaul.*"

Some writers, through heat of imagination, fall into contradiction; fome are guilty of downright abfurdities; and fome even rave like madmen. Againft fuch capital errors one cannot be more effectually warned than by collecting inftances; and the firft fhall be of a contradiction, the moft venial of all. Virgil fpeaking of Neptune, Narration.

Interea magno mifcere murmure pontum,
Emiffamque hyemem fenfit Neptunus, et imis
Stagna refufa vadis: *graviter commotus*, et alto
Profpiciens, fummâ *placidum* caput extulit undâ.

Æneid. i. 128.

Again:

When firft young Maro, in his boundlefs mind,
A work t'outlaft *immortal* Rome defigned.

Effay on Criticifm, l. 30.

The following examples are of abfurdities.

" Alii pulfis e tormento catenis difcerpti fectique, dimidiato corpore pugnabant fibi fuperftites, ac peremptæ partes ultores." *Strada, dec.* 2. *l.* 2.

Il povér huomo, che non fen' era accorto,
Andava combattendo, ed era morto. *Berni.*

He fled, but flying, left his life behind.

Iliad xi. 443.

Full through his neck the weighty falchion fped:
Along the pavement roll'd the mutt'ring head.

Odyffey xxii. 365.

The laft article is of raving like one mad. Cleopatra fpeaking to the afpic,

——————Welcome, thou kind deceiver,
Thou beft of thieves; who, with an eafy key,
Doft open life, and unpèrceiv'd by us
Even fteal us from ourfelves; difcharging fo
Death's dreadful office, better than himfelf;
Touching our limbs fo gently into flumber,
That Death ftands by, deceiv'd by his own image,
And thinks himfelf but fleep.

Dryden, All for Love, act 5.

Having difcuffed what obfervations occurred upon the thoughts or things expreffed, we proceed to what more peculiarly concern the language or verbal drefs. As words are intimately connected with the ideas they reprefent, the emotions raifed by the found and by the fenfe ought to be concordant. An elevated fubject requires an elevated ftyle; what is familiar, ought to be familiarly expreffed: a fubject that is ferious and important, ought to be clothed in plain nervous language: a defcription, on the other hand, addreffed to the imagination, is fufceptible of the higheft ornaments that founding words and figurative expreffion can beftow upon it.

We fhall give a few examples of the foregoing rules. A poet of any genius is not apt to drefs a high fubject in low words; and yet blemifhes of that kind are found even in claffical works. Horace, obferving that men are fatisfied with themfelves, but feldom with their condition, introduces Jupiter indulging to each his own choice:

Jam faciam quod vultis: eris tu, qui modo miles,
Mercator: tu, confultus modo, rufticus: hinc vos,
Vos hinc mutatis difcedite partibus: eia.
Quid ftatis? nolint: atqui licet effe beatis.
Quid caufæ eft, merito quin illis *Jupiter ambas*
Iratas buccas inflet? neque fe fore pofthac
Tam facilem dicat, votis ut præbeat aurem?

Sat. lib. 1. *fat.* 1. *l.* 16.

Jupiter in wrath puffing up both cheeks, is a low and even ludicrous expreffion, far from fuitable to the gravity

vity and importance of the fubject: every one muft feel the difcordance. The following couplet, finking far below the fubject, is no lefs ludicrous:

Not one looks backward, onward ftill he goes,
Yet ne'er looks forward farther than his nofe.
Effay on Man, ep. iv. 223.

On the other hand, to raife the expreffion above the tone of the fubject, is a fault than which none is more common. Take the following inftances:

Orcan le plus fidéle à ferver fes deffeins,
Ne fous le ciel brûlant des plus noirs Affricains.
Bajazet, act 3. *fc.* 8.

Les ombres par trois fois ont obfcurci les cieux
Depuis que le fommeil n'eft entré dans vos yeux;
Et le jour a trois fois chaffé la nuit obfcure
Depuis que votre corps languit fans nourriture.
Phedra, act 1. *fc.* 3.

Affueris. Ce mortel, qui montra tant de zéle pour moi, Vit-il encore?
Afaph.———Il voit l'aftre qui vous éclaire.
Efther, act 2. *fc.* 3.

Oui, c'eft Agamemnon, c'eft ton roi qui t'eveille;
Viens, reconnois la voix qui frappe ton oreille.
Iphigenie.

No jocund health that Denmark drinks to-day,
But the great cannon to the clouds fhall tell;
And the king's rowfe the heav'n fhall bruit again,
Refpeaking earthly thunder.
Hamlet, act 1. *fc.* 2.

————————In the inner room
I fpy a winking lamp, that weakly ftrikes
The ambient air, fcarce kindling into light.
Southerne, Fate of Capua, act 3.

In the funeral orations of the bifhop of Meaux, the following paffages are raifed far above the tone of the fubject:

" L'Ocean etonné de fe voir traverfé tant de fois, en des appareils fi divers, et pour des caufes fi differentes, &c." - *p.* 6.

" Grande reine, je fatisfais à vos plus tendres defirs, quand je célébre ce monarque; et fon cœur qui n'a jamais vêcu que pour lui, fe eveille, tout poudre qu'il eft, et devient fenfible, même fous ce drap mortuaire, au nom d'un epoux fi cher." *p.* 32.

The following paffage, intended, one would imagine, as a receipt to boil water, is altogether burlefque by the laboured elevation of the diction:

A maffy caldron of ftupendous frame
They brought, and plac'd it o'er the rifing flame:
Then heap the lighted wood; the flame divides
Beneath the vafe, and climbs around the fides:
In its wide womb they pour the rufhing ftream:
The boiling water bubbles to the brim.
Iliad. xviii. 405.

In a paffage at the beginning of the 4th book of Telemachus, one feels a fudden bound upward without preparation, which accords not with the fubject:

" Calypfo, qui avoit été jufqu' à ce moment immobile et tranfportée de plaifir en écoutant les avantures de Télémaque, l'interrompit pour lui faire prendre quelque repôs. Il eft tems, lui dit-elle, que vous alliez goûter la douceur du fommeil aprés tant de travaux. Vous n'avez rien à craindre ici; tout vous eft favorable. Abandonnez vous donc à la joye. Goutez la paix, et tous les autres dons des dieux dont vous allez être comblé. Demain, *quand l'Aurore avec fes doigts de rôfes entr'ouvira les portes dorées de l'Orient, et que le chevaux du foleil fortans de l'onde amére répandront les flames du jour, pour chaffer devant eux toutes les etoiles du ciel,* nous reprendrons, mon cher Télémaque, l'hiftoire de vos malheurs."

This obvioufly is copied from a fimilar paffage in the Æneid, which ought not to have been copied, becaufe it lies open to the fame cenfure; but the force of authority is great:

At regina gravi jamdudum faucia cura
Vulnus alit venis, et cæco carpitur igni.
Multa viri virtus animo, multufque recurfat
Gentis honos: hærent infixi pectore vultus,
Verbaque: nec placidam membris dat cura quietem
Poftera Phœbea luftrabat lampade terras,
Humentemque Aurora polo dimoverat umbram;
Cum fic unanimem alloquitur malefana fororem.
Lib. iv. 1

The language of Homer is fuited to his fubject, not lefs accurately than the actions and fentiments of his heroes are to their characters. Virgil, in that particular, falls fhort of perfection: his language is ftately throughout: and though he defcends at times to the fimpleft branches of cookery, roafting and boiling for example, yet he never relaxes a moment from the high tone. In adjufting his language to his fubject, no writer equals Swift. We can recollect but one exception. which at the fame time is far from being grofs: The Journal of a modern Lady is compofed in a ftyle blending fprightlinefs with familiarity, perfectly fuited to the fubject: in one paffage, however, the poet, deviating from that ftyle, takes a tone above his fubject. The paffage we have in view begins *l.* 116. *But let me now a while furvey, &c.* and ends at *l.* 135.

It is proper to be obferved upon this head, that writers of inferior rank are continually upon the ftretch to enliven and enforce their fubject by exaggeration and fuperlatives. This unluckily has an effect contrary to what is intended: the reader, difgufted with language that fwells above the fubject, is led by contraft to think more meanly of the fubject than it may poffibly deferve. A man of prudence, befide, will be no lefs careful to hufband his ftrength in writing than in walking: a writer too liberal of fuperlatives, exhaufts his whole ftock upon ordinary incidents, and referves no fhare to exprefs, with greater energy, matters of importance.

Many writers of that kind abound fo in epithets, as if poetry confifted entirely in high-founding words. Take the following inftance:

When black-brow'd night her dufky mantle fpread,
And wrapt in folemn gloom the fable fky;
When foothing fleep her opiate dews had fhed,
And feal'd in filken flumbers ev'ry eye:
My wakeful thought admits no balmy reft,
Nor the fweet blifs of foft oblivion fhare:
But watchful wo diftracts my aching breaft,
My heart the fubject of corroding care:
From haunts of men with wandring fteps and flow
I folitary fteal, and foothe my penfive wo.

Here every fubftantive is faithfully attended by fome tumid

Narration. tumid epithet.

We proceed to a fecond remark, not lefs important than the former. No perfon of reflection but muft be fenfible, that an incident makes a ftronger impreffion on an eye-witnefs, than when heard at fecond-hand. Writers of genius, fenfible that the eye is the beft avenue to the heart, reprefent every thing as paffing in our fight; and, from readers or hearers, transform us as it were into fpectators: a fkilful writer conceals himfelf, and prefents his perfonages: in a word, every thing becomes dramatic as much as poffible. Plutarch, *de gloria Athenienfium*, obferves, that Thucydides makes his reader a fpectator, and infpires him with the fame paffions as if he were an eye-witnefs.

In the fine arts, it is a rule, to put the capital objects in the ftrongeft point of view; and even to prefent them oftener than once, where it can be done. In hiftory-painting, the principal figure is placed in the front, and in the beft light: an equeftrian ftatue is placed in a centre of ftreets, that it may be feen from many places at once. In no compofition is there greater opportunity for this rule than in writing:

———Sequitur pulcherrimus Aftur,
Aftur equo fidens et verficoloribus armis.
Æneid. x. 180.

———Full many a lady
I've ey'd with beft regard, and many a time
Th' harmony of their tongues hath into bondage
Brought my too diligent ear: for feveral virtues
Have I lik'd feveral women; never any
With fo full foul, but fome defect in her
Did quarrel with the nobleft grace fhe ow'd,
And put it to the foil. But you, O you,
So perfect, and fo peerlefs, are created
Of every creature's beft. *Tempeft, act* 3. *fc.* 1.

Orlando.——— Whate'er you are
That, in the defart inacceffible,
Under the fhade of melancholy boughs,
Lofe and neglect the creeping hours of time;
If ever you have look'd on better days;
If ever been where bells have knoll'd to church;
If ever fat at any good man's feaft;
If ever from your eye-lids wip'd a tear,
And know what 'tis to pity, and be pity'd;
Let gentlenefs my ftrong inforcement be,
In the which hope I blufh, and hide my fword.

Duke fen. True is it that we have feen better days;
And have with holy bell been knoll'd to church;
And fat at good mens feafts; and wip'd our eyes
Of drops that facred pity had engender'd:
And therefore fit you down in gentlenefs,
And take upon command what help we have,
That to your wanting may be miniftred.
As you like it.

With the converfing I forgot all time;
All feafons and their change, all pleafe alike.
Sweet is the breath of morn, her rifing fweet,
With charm of earlieft birds; pleafant the fun
When firft on this delightful land he fpreads
His orient beams, on herbs, tree, fruit, and flow'r
Gliftering with dew; fragrant the fertile earth
After foft fhow'rs; and fweet the coming on
Of grateful ev'ning mild, the filent night
With this her folemn bird, and this fair moon,
And thefe the gems of heav'n, her ftarry train:
But neither breath of morn, when fhe afcends
With charm of earlieft birds, nor rifing fun
On this delightful land, nor herb, fruit, flow'r,
Gliftering with dew, nor fragrance after fhowr's,
Nor grateful ev'ning mild, nor filent night,
With this her folemn bird, nor walk by moon,
Or glittering ftar-light, without thee is fweet.
Paradife Loft, book 4. *l* 634.

"What mean ye, that ye ufe this proverb, The fathers have eaten four grapes, and the childrens teeth are fet on edge? As I live, faith the Lord God, ye fhall not have occafion to ufe this proverb in Ifrael. If a man keep my judgments to deal truly, he is juft, he fhall furely live. But if he be a robber, a fhedder of blood; if he have eaten upon the mountains, and defiled his neighbour's wife; if he have oppreffed the poor and needy, have fpoiled by violence, have not reftored the pledge, have lift up his eyes to idols, have given forth upon ufury, and have taken increafe: fhall he live? he fhall not live: he fhall furely die; and his blood fhall be upon him. Now, lo, if he beget a fon, that feeth all his father's fins, and confidereth, and doeth not fuch like; that hath not eaten upon the mountains, hath not lift up his eyes to idols, nor defiled his neighbour's wife, hath not oppreffed any, nor withheld the pledge, neither hath fpoiled by violence, but hath given his bread to the hungry, and covered the naked with a garment; that hath not received ufury nor increafe, that hath executed my judgments, and walked in my ftatutes: he fhall not die for the iniquity of his father; he fhall furely live. The foul that finneth, it fhall die; the fon fhall not bear the iniquity of the father, neither fhall the father bear the iniquity of the fon; the righteoufnefs of the righteous fhall be upon him, and the wickednefs of the wicked fhall be upon him. Have I any pleafure that the wicked fhould die, faith the Lord God; and not that he fhould return from his ways, and live?" *Ezekiel* xviii.

A concife comprehenfive ftyle is a great ornament in narration; and a fuperfluity of unneceffary words, not lefs than of circumftances, a great nuifance. A judicious felection of the ftriking circumftances, clothed in a nervous ftyle, is delightful. In this ftyle, Tacitus excels all writers, ancient and modern. Inftances are numberlefs: take the following fpecimen.

"Crebra hinc prælia, et fæpius in modum latrocinii: per faltus, per paludes; ut cuique fors aut virtus: temerè, provifo, ob iram, ob prædam, juffu, et aliquando ignaris ducibus." *Annal. lib.* 12. § 39.

After Tacitus, Offian in that refpect juftly merits the place of diftinction. One cannot go wrong for examples in any part of the book.

If a concife or nervous ftyle be a beauty, tautology muft be a blemifh; and yet writers, fettered by verfe, are not fufficiently careful to avoid this flovenly practice: they may be pitied, but they cannot be juftified. Take for a fpecimen the following inftances, from the beft poet, for verfification at leaft, that England has to boaft of.

High on his helm celeftial lightnings play,
His beamy fhield emits a living ray;
The unweary'd blaze inceffant ftreams fupplies,
Like the red ftar that fires th' autumnal fkies.
Iliad v. 5.

Strength

Strength and omnipotence inveſt thy throne.
Ibid. viii. 576.

So ſilent fountains, from a rock's tall head,
In ſable ſtreams ſoft trickling waters ſhed.
Ibid. ix. 19.

His clanging armour rung. *Ibid.* xii. 94.

Fear on their cheek, and horror in their eye.
Ibid. xv. 4.

The blaze of armour flaſh'd againſt the day.
Ibid. xvii. 736.

As when the piercing blaſts of Boreas blow.
Ibid. xix. 380.

And like the moon, the broad refulgent ſhield
Blaz'd with long rays, and gleam'd athwart the field.
Ibid. xix. 402.

No—could our ſwiftneſs o'er the winds prevail,
Or beat the pinions of the weſtern gale,
All were in vain —— *Ibid.* xix. 604.

The humid ſweat from ev'ry pore deſcends.
Ibid. xxiii. 829.

We cloſe this article with a curious inquiry. An object, however ugly to the ſight, is far from being ſo when repreſented by colours or by words. What is the cauſe of this difference? With reſpect to painting, the cauſe is obvious: a good picture, whatever the ſubject be, is agreeable by the pleaſure we take in imitation; and this pleaſure overbalancing the diſagreeableneſs of the ſubject, makes the picture upon the whole agreeable. With reſpect to the deſcription of an ugly object, the cauſe follows. To connect individuals in the ſocial ſtate, no particular contributes more than language, by the power it poſſeſſes of an expeditious communication of thought, and a lively repreſentation of tranſactions. But nature hath not been ſatisfied to recommend language by its utility merely: independent of utility, it is made ſuſceptible of many beauties, which are directly felt, without any intervening reflection. And this unfolds the myſtery; for the pleaſure of language is ſo great, as in a lively deſcription to overbalance the diſagreeableneſs of the image raiſed by it. This, however, is no encouragement to chooſe a diſagreeable ſubject; for the pleaſure is incomparably greater where the ſubject and the deſcription are both of them agreeable.

The following deſcription is upon the whole agreeable, though the ſubject deſcribed is in itſelf diſmal:

Nine times the ſpace that meaſures day and night
To mortal men, he with his horrid crew
Lay vanquiſh'd, rolling in the fiery gulf,
Confounded though immortal! but his doom
Reſerv'd him to more wrath; for now the thought
Both of loſt happineſs and laſting pain
Torments him; round he throws his baleful eyes
That witneſs'd huge affliction and diſmay,
Mix'd with obdurate pride and ſtedfaſt hate:
At once as far as angels ken he views
The diſmal ſituation waſte and wild:
A dungeon horrible, on all ſides round
As one great furnace flamed; yet from thoſe flames
No light, but rather darkneſs viſible
Serv'd only to diſcover ſights of wo,
Regions of ſorrow, doleful ſhades, where peace
And reſt can never dwell, hope never comes
That comes to all; but torture without end
Still urges, and a fiery deluge, fed
With ever-burning ſulphur unconſum'd!
Such place eternal juſtice had prepar'd
For thoſe rebellious. *Paradiſe loſt, book.* 1. *l.* 50.

An unmanly depreſſion of ſpirits in time of danger is not an agreeable ſight; and yet a fine deſcription or repreſentation of it will be reliſhed:

K. Richard. What muſt the King do now! muſt he ſubmit?
The king ſhall do it: muſt he be depos'd?
The king ſhall be contented: muſt he loſe
The name of king? o' God's name, let it go;
I'll give my jewels for a ſet of beads;
My gorgeous palace, for a hermitage;
My gay apparel, for an almſman's gown;
My figur'd goblets, for a diſh of wood;
My ſceptre, for a palmer's walking-ſtaff;
My ſubjects, for a pair of carved ſaints;
And my large kingdom, for a little grave;
A little, little grave;——an obſcure grave.
Or I'll be bury'd in the king's highway;
Some way of common tread, where ſubjects feet
May hourly trample on their ſovereign's head;
For on my heart they tread now, whilſt I live;
And, bury'd once, why not upon my head?
Richard II. act. 3. *ſc.* 6.

Objects that ſtrike terror in a ſpectator, have in poetry and painting a fine effect. The picture, by raiſing a ſlight emotion of terror, agitates the mind; and in that condition every beauty makes a deep impreſſion. May not contraſt heighten the pleaſure, by oppoſing our preſent ſecurity to the danger of encountering the object repreſented?

—————The other ſhape,
If ſhape it might be call'd, that ſhape had none
Diſtinguiſhable in member, joint, or limb;
Or ſubſtance might be call'd that ſhadow ſeem'd,
For each ſeem'd either; black it ſtood as night,
Fierce as ten furies, terrible as hell,
And ſhook a dreadful dart. *Par. loſt, b.* 2. *l.* 666.

————— Now ſtorming fury roſe,
And clamour ſuch as heard in heaven till now
Was never: arms on clamour claſhing bray'd
Horrible diſcord, and the madding wheels
Of brazen chariots rag'd; dire was the noiſe
Of conflict; overhead the diſmal hiſs
Of fiery darts in flaming vollies flew,
And flying vaulted either hoſt with fire.
So under fiery cope together ruſh'd
Both battles main, with ruinous aſſault
And inextinguiſhable rage: all heaven
Reſounded, and had earth been then, all earth
Had to her centre ſhook. *Ibid. book* 6. *l.* 207.

Ghoſt. ————— But that I am forbid
To tell the ſecrets of my priſon-houſe,
I could a tale unfold, whoſe lighteſt word
Would harrow up thy ſoul, freeze thy young blood,
Make thy two eyes, like ſtars, ſtart from their ſpheres,
Thy knotty and combined locks to part,
And each particular hair to ſtand on end,
Like quills upon the fretful porcupine:
But this eternal blazon muſt not be
To ears of fleſh and blood. *Hamlet, act* 1. *ſc.* 8.

Gratiano.

Gratiano. Poor Desdemona! I'm glad thy father's dead:
Thy match was mortal to him; and pure grief
Shore his old thread in twain. Did he live now,
This sight would make him do a desp'rate turn:
Yea, curse his better angel from his side,
And fall to reprobation. *Othello, act* 5. *sc.* 8.

Objects of horror must be excepted from the foregoing theory; for no description, however lively, is sufficient to overbalance the disgust raised even by the idea of such objects. Every thing horrible ought therefore to be avoided in a description.

NARWAL, in ichthyology. See MONODON.

NASSAU-SIEGEN, a small principality of Germany in the Westerwalde, is in general a mountainous woody country, with some arable and pasture ground, and a good breed of cattle. Its manufactures are chiefly those of iron and steel, having an iron mine in the neighbourhood of Siegen. Count John the Younger, in 1626, embraced the Roman Catholic religion, and endeavoured to introduce it into the country; but the principality, upon the extinction of the line of Nassau Siegen in 1743, falling to the line of Nassau-Dietz, and therein to the prince of Orange, hereditary stadtholder of the United Provinces, the Protestants were delivered from their apprehensions of Popish tyranny and bigotry. The prince, on account of these territories, has a seat and voice at the diets of the empire and circle in the college of princes. His assessment in the matricula for Nassau-Siegen is 773 florins monthly; and towards the maintenance of the chamber judicatory, 50 rix-dollars six kruitzers and a half, each term. The revenue of this principality is estimated at 100,000 rix-dollars.

NASSAU-*Dillenbourg*, a principality of Germany, situated near the former. It has not much arable land, but plenty of wood, good quarries of stone, some silver and vitriol, copper and lead, with store of iron, for the working and smelting of which there are many forges and founderies in the country; and by these, and the sale of their iron, the inhabitants chiefly subsist. Calvinism is the religion of the principality, which contains five towns and two boroughs, and belongs entirely to William V. prince of Orange, and hereditary stadtholder of the United Provinces, whose father succeeded to a part of it in 1739, on the death of prince Christian, and to the rest in 1743, on the death of prince William Hyacynth of Siegen. The prince, on account of this principality also and Dietz, has a seat and voice in the college of princes, at the diets of the empire and circle. His assessment in the matricula, for Nassau-Dillenbourg, is 102 florins monthly; and to the chamber-judicatory, 50 rix-dollars six and a half kruitzers, each term. His revenue from this principality is computed at above 130,000 florins.

NASSAU-*Hadamar*, a county of Germany, which, till the year 1711, had princes of its own; but now belongs wholly to William V. prince of Orange.

NATES, in anatomy, a term expressing those two fleshy exterior parts of the body vulgarly called the *buttocks*.

NATION, a collective term, used for a considerable number of people inhabiting a certain extent of land, confined within fixed limits, and under the same government.

NATIONAL DEBT; the money owing by government.

In order to take a clear and comprehensive view of the nature of this national debt, it must first be premised, that after the Revolution, when new connections with Europe introduced a new system of foreign politics, the expences of the nation, not only in settling the new establishment, but in maintaining long wars, as principals, on the continent, for the security of the Dutch barrier, reducing the French monarchy, settling the Spanish succession, supporting the house of Austria, maintaining the liberties of the Germanic body, and other purposes, increased to an unusual degree: insomuch, that it was not thought adviseable to raise all the expences of any one year by taxes to be levied within that year, lest the unaccustomed weight of them should create murmurs among the people. It was therefore the policy of the times to anticipate the revenues of their posterity, by borrowing immense sums for the current service of the state, and to lay no more taxes upon the subject than would suffice to pay the annual interest of the sums so borrowed: by this means converting the principal debt into a new species of property, transferable from one man to another at any time and in any quantity. A system which seems to have had its original in the state of Florence, A. D. 1344: which government then owed about 60,000 l. Sterling; and being unable to pay it, formed the principal into an aggregate sum, called metaphorically a *mount* or *bank*, the shares whereof were transferable like our stocks, with interest at 5 *per cent.* the prices varying according to the exigencies of the state. This laid the foundation of what is called the *national debt:* for a few long annuities created in the reign of Charles II. will hardly deserve that name. And the example then set has been so closely followed during the long wars in the reign of queen Anne, and since, that the capital of the national debt, (funded and unfunded) amounted in January 1771 to above 140,000,000 l.; to pay the interest of which, and the charges of management, amounting annually to upwards of four millions and an half, the extraordinary revenues elsewhere enumerated † (excepting only the land-tax and annual malt-tax) are in the first place mortgaged and made perpetual by parliament. Perpetual we say; but still redeemable by the same authority that imposed them: which, if it at any time can pay off the capital, will abolish those taxes which are raised to discharge the interest.

Blackst. Comment.

† See Revenue.

By this means the quantity of property in the kingdom is greatly increased in idea, compared with former times; yet, if we coolly consider it, not at all increased in reality. We may boast of large fortunes, and quantities of money in the funds. But where does this money exist? It exists only in name, in paper, in public faith, in parliamentary security: and that is undoubtedly sufficient for the creditors of the public to rely on. But then what is the pledge which the public faith has pawned for the security of these debts? The land, the trade, and the personal industry of the subject; from which the money must arise that supplies the several taxes. In these therefore, and these only,

only, the property of the public creditors does really and intrinfically exift: and of courfe the land, the trade, and the perfonal induftry of individuals, are diminifhed in their true value juft fo much as they are pledged to anfwer. If A's income amounts to 100 l. *per annum;* and he is fo far indebted to B, that he pays him 50 l. *per annum* for his intereft; one half of the value of A's property is transferred to B the creditor. The creditor's property exifts in the demand which he has upon the debtor, and no where elfe; and the debtor is only a truftee to his creditor for one half of the value of his income. In fhort, the property of a creditor of the public confifts in a certain portion of the national taxes: by how much therefore he is the richer, by fo much the nation, which pays thefe taxes, is the poorer.

The only advantage, that can refult to a nation from public debts, is the increafe of circulation, by multiplying the cafh of the kingdom, and creating a new fpecies of currency, affignable at any time and in any quantity; always therefore ready to be employed in any beneficial undertaking, by means of this its transferable quality; and yet producing fome profit even when it lies idle and unemployed. A certain proportion of debt feems to be highly ufeful to a trading people; but what that proportion is, it is not for us to determine. This much is indifputably certain, that the prefent magnitude of our national encumbrances very far exceeds all calculations of commercial benefit, and is productive of the greateft inconveniencies. For, firft, the enormous taxes, that are raifed upon the neceffaries of life for the payment of the intereft of this debt, are a hurt both to trade and manufactures, by raifing the price as well of the artificer's fubfiftence as of the raw material, and of courfe, in a much greater proportion, the price of the commodity itfelf. Nay, the very increafe of paper-circulation itfelf, when extended beyond what is requifite for commerce or foreign exchange, has a natural tendency to increafe the price of provifions as well as of all other merchandife. For as its effect is to multiply the cafh of the kingdom, and this to fuch an extent, that much muft remain unemployed, that cafh (which is the univerfal meafure of the refpective values of all other commodities) muft neceffarily fink in its own value, and every thing grow comparatively dearer. Secondly, if part of this debt be owing to foreigners, either they draw out of the kingdom annually a confiderable quantity of fpecie for the intereft; or elfe it is made an argument to grant them unreafonable privileges in order to induce them to refide here. Thirdly, if the whole be owing to fubjects only, it is then charging the active and induftrious fubject, who pays his fhare of the taxes to maintain the indolent and idle creditor who receives them. Laftly, and principally, it weakens the internal ftrength of a ftate, by anticipating thofe refources which fhould be referved to defend it in cafe of neceffity. The intereft we now pay for our debts would be nearly fufficient to maintain any war that any national motives could require. And if our anceftors in king William's time had annually paid, fo long as their exigencies lafted, even a lefs fum than we now annually raife upon their accounts, they would in the time of war have borne no greater burdens than they have bequeathed to and fettled upon their pofterity in time of peace; and might have been eafed the inftant the exigence was over. See FUNDS.

NATIVITY, or NATAL DAY, the day of a perfon's birth. The word *nativity* is chiefly ufed in fpeaking of the faints; as, the nativity of St John the Baptift, &c. But when we fay *the* Nativity, it is underftood of that of Jefus Chrift, or the feaft of Chriftmas.

NATOLIA, the modern name of the Leffer Afia, being the moft wefterly part of Turkey in Afia, and confifting of a large peninfula, which extends from the river Euphrates, as far as the Archipelago, the feas of Marmora, the ftraits of Galipoli and of Conftantinople, which feparate it from Europe on the weft. It is bounded on the north by the Black fea, and on the fouth by the Mediterranean fea.

NATRUM, the nitre of the ancients, in natural hiftory, is a genuine, pure, and native falt, extremely different from our nitre, and indeed from all the other native falts; it being a fixed alkali, plainly of the nature of thofe made by fire from vegetables, yet capable of a regular cryftallization, which thofe falts are not. It is found on the furface of the earth, or at very fmall depths within it; and is naturally formed into thin and flat cakes or crufts, which are of a fpungy or cavernous fubftance, very light and friable, and, when pure, of a pale brownifh white; but as its fpungy texture renders it very fubject to be fouled by earth received into its pores, it is often met with of a deep dirty brown, and not unfrequently reddifh.

Natrum, whether native or purified, diffolves in a very fmall quantity of water; and this folution is, in many parts of Afia, ufed for wafhing; where it is alfo made into foap, by mixing it with oil. Natrum reduced to powder, and mixed with fand or flints, or with any other ftone of which cryftal is the bafis, make them readily run into glafs. Gold heated red-hot, and fprinkled with a fmall quantity of this falt, melts immediately; filver ignited and fprinkled with it, melts in the fame manner; as does alfo iron, copper, and the regulus of antimony, which melt much more eafily than they otherwife would do. Mercury will not be mixed with it by any art, and indeed will not amalgamate with metals if only a little of this falt be added. It is found in great abundance in many parts of Afia, where the natives fweep it up from the furface of the ground, and call it *foap-earth.* The earlieft account we have of it is in the fcriptures, where we find that the falt called *nitre* in thofe times would ferment with vinegar, and had an abfterfive quality, fo that it was ufed in baths and in wafhing things. Solomon compares the finging of fongs with a heavy heart, to the contrariety of vinegar and nitre; and Jeremiah fays, that if the finner wafh himfelf with nitre, his fin is not cleanfed off. Thefe are properties that perfectly agree with this falt, but not at all with our faltpetre.

NATTER-JACK, in zoology, a fpecies of RANA.

NATURAL, in general, fomething that relates to nature. See NATURE.

NATURAL *Children,* are thofe born out of lawful wedlock. See BASTARD.

NATURAL *Functions,* are thofe actions whereby the aliments are changed and affimilated fo as to become

Natural. come a part of the body.

Natural, in heraldry, is used where animals, fruits, flowers, &c. are blazoned with the colours they naturally have, though different from the common colours of heraldry: and this is to prevent the armories being accused of falsity, when blazoned with the names of colours unknown in heraldry.

Natural *Note*, in music, is used in opposition to flat and sharp notes, which are called *artificial notes*. See Note, Scale, &c.

Natural is also used for something coming immediately out of the hands of nature: in which sense it stands opposed to *factitious* or artificial, which signifies something wrought by art. See Artificial.

Bishop Wilkins observes, that there appears a world of difference between natural and artificial things, when viewed with microscopes. The first ever appear adorned with all imaginable elegance and beauty; the latter, though the most curious in their kind, infinitely rude and unhewn: the finest needle appears a rough bar of iron; and the most accurate engraving or embossment as if done with a mattock or trowel.

NATURAL HISTORY.

Natural history, is that science which not only gives complete descriptions of natural productions in general, but also teaches the method of arranging them into classes, orders, genera, and species. This definition includes zoology, botany, mineralogy, &c. But as a science so various and comprehensive could neither with propriety nor advantage be completely discussed under the general title, we have to refer the reader to the article Kingdoms *(in Natural History)*, where he will be directed to the different articles which constitute either the branches or the objects of the science, and which are all treated under their respective names.—In the present article it is proposed to give a general and philosophical view of the subject: To set forth, in a summary way, whatever curious, worthy to be known, or not obvious to every observer, occurs in the three kingdoms of nature: with their constitution, laws, and œconomy; or, in other words, that all-wise disposition of the Creator in relation to natural things, by which they are fitted to produce general ends and reciprocal uses.

Sect. I. *Of the Terraqueous Globe in general, and its changes.*

The world, or the terraqueous globe, which we inhabit, is every-where surrounded with elements, and contains in its superficies the three Kingdoms *of Nature*, as they are called: the fossil, which constitutes the crust of the earth; the vegetable, which adorns the face of it, and draws the greatest part of its nourishment from the fossil kingdom; and the animal, which is sustained by the vegetable kingdom. Thus these three kingdoms cover, adorn, and vary the superficies of our earth.

As to the strata of the earth and mountains, as far as we have hitherto been able to discover, the upper parts consist of rag-stone; the next of slate; the third of marble filled with petrifactions; the fourth again, of slate; and lastly, the lowest of free-stone. The habitable part of the earth, though it is scooped into various inequalities, yet is every-where high in comparison with the water; and the farther it is from the sea, it is generally higher. Thus the waters in the lower places are not at rest, unless some obstacle confines them, and by that means form lakes and marshes.

The sea surrounds the continent, and takes up the greatest part of the earth's superficies, as geography informs us. Nay, that it once spread over much the greatest part, we may be convinced by its yearly decrease, by the rubbish left by the tides, by shells, strata, and other circumstances.

The sea-shores are usually full of dead testaceous animals, wrack, and such like bodies, which are yearly thrown out of the sea. They are also covered with sand of various kinds, stones, and heaps of other things not very common. It happens, moreover, that while the more rapid rivers rush through narrow valleys, they wear away the sides; and thus the friable and soft earth falls in, and its ruins are carried to distant and winding shores; whence it is certain, that the continent gains no small increase, as the sea subsides.

The clouds collected from exhalations, chiefly from the sea, but likewise from other waters, and moist grounds, and condensed in the lower regions of the atmosphere, supply the earth with rain; but since they are attracted by the mountainous parts of the earth, it necessarily follows, that those parts must have, as is fit, a larger share of water than the rest. Springs, which generally rush out at the foot of mountains, take their rise from this very rain-water and vapours condensed, that trickle through the holes and interstices of loose bodies, and are received into caverns.

These afford a pure water purged by straining; and rarely dry up in summer, or freeze in winter, so that animals never want a wholesome and refreshing liquor.

The chief sources of rivers are fountains and rills growing by gradual supplies into still larger and larger streams; till at last, after the conflux of a vast number of them, they find no stop, but falling into the sea with much rapidity, they there deposit the united stores they have gathered, along with foreign matter, and such earthy substances as they tore off in their way. Thus the water returns in a circle whence it first drew its origin, that it may act over the same scene again.

Marshes arising from water retained in low grounds are filled with mossy tumps, which are brought down by the water from the higher parts, or are produced by putrified plants.

We often see new meadows arise from marshes dried up. This happens sooner when the *sphagnum* (a kind of moss) has laid a foundation; for this in process of time changes into a very porous mould, till almost the whole marsh is filled with it. After that the rush strikes root, and along with the cotton-grasses constitutes a turf, raised in such a manner, that the roots get continually higher, and thus lay a more firm foundation for other plants, till the whole marsh is changed into a fine and delightful meadow; especially if the water happens to work itself a new passage.

Hillocks,

Of the Terraqueous globe.

Hillocks, that abound in low grounds, occasion the earth to increase yearly, more than the countryman would wish, and seem to do hurt: but in this the great industry of nature deserves to be taken notice of. For by this means the barren spots become sooner rich meadow and pasture land. These hillocks are formed by the ant, by stones and roots, and the trampling of cattle: but the principal cause is the force of the winter-cold, which in the spring raises the roots of plants so high above the ground, that being exposed to the air, they grow, and perish; after which the golden maidenhairs fill the vacant places.

Mountains, hills, valleys, and all the inequalities of the earth, though some think they take away much from its beauty, are so far from producing such an effect, that on the contrary they give a more pleasing aspect, as well as great advantages. For thus the terrestrial superficies is larger; different kinds of plants thrive better, and are more easily watered; and the rain-waters run in continual streams into the sea; not to mention many other uses in relation to winds, heat, and cold. Alps are the highest mountains, that reach to the second region of the air, where trees cannot grow erect. The higher these Alps are, the the colder they are *cæteris paribus*. Hence the Alps in Sweden, Siberia, Swisserland, Peru, Brasil, Armenia, Asia, Africa, are perpetually covered with snow, which becomes almost as hard as ice. But if by chance the summer-heats be greater than ordinary, some part of these stores melts, and runs through rivers into the lower regions, which by this means are much refreshed.

It is scarcely to be doubted, but that the rocks and stones dispersed over the globe were formed originally in, and from, the earth; but when torrents of rain have softened, as they easily do, the soluble earth, and carried it down into the lower parts, we imagine it happens, that these solid and heavy bodies, being laid bare, stick out above the surface. We might also take notice of the wonderful effect of the tide, such as we see happen from time to time on the sea-shore, which being daily and nightly assaulted with repeated blows, at length gives way, and breaks off. Hence we see in most places the rubbish of the sea, and shores.

The winter by its frost prepares the earth and mould, which thence are broken into very minute particles, and thus, being put into a mouldering state, become more fit for the nourishment of plants; nay, by its snow it covers the seeds, and roots of plants, and thus by cold defends them from the force of cold. We must add also, that the piercing frost of the winter purifies the atmosphere and putrid waters, and makes them more wholesome for animals.

The perpetual succession of heat and cold with us renders the summers more pleasing: and tho' the winter deprives us of many plants and animals, yet the perpetual summer within the tropics is not much more agreeable, as it often destroys men and other animals by its immoderate heat; though it must be confessed, that those regions abound with exquisite fruits. Our winters, though very troublesome to a great part of the globe on account of their vehement and intense cold, yet are less hurtful to the inhabitants of the northern parts, as experience testifies. Hence it happens, that we may live very conveniently on every part of the earth, as every different country has different advantages from nature.

Of the Seasons.

The seasons, like every thing else, have their vicissitudes; their beginnings, their progress, and their end.

The age of man begins from the cradle; pleasing childhood succeeds; then active youth; afterwards manhood, firm, severe, and intent upon self-preservation; lastly, old age creeps on, debilitates, and at length totally destroys our tottering bodies.

The seasons of the year proceed in the same way. Spring, the jovial, playful infancy of all living creatures, represents childhood and youth; for then plants spread forth their luxuriant flowers, fishes exult, birds sing, every part of nature is intent upon generation. The summer, like middle age, exhibits plants, and trees every-where cloathed with green; it gives vigour to animals, and plumps them up; fruits then ripen, meadows look cheerful, every thing is full of life. On the contrary, autumn is gloomy; for then the leaves of trees begin to fall, plants to wither, insects to grow torpid, and many animals to retire to their winter-quarters.

The day proceeds with just such steps, as the year. The morning makes every thing alert, and fit for business: the sun pours forth his ruddy rays; the flowers, which had as it were slept all night, awake and expand themselves again; the birds with their sonorous voices and various notes make the woods ring, meet together in flocks, and sacrifice to Venus. Noon tempts animals into the fields and pastures; the heat puts them upon indulging their ease, and even necessity obliges them to it. Evening follows, and makes every thing more sluggish; flowers shut up*, and animals retire to their lurking places. Thus the spring, the morning, and youth, are proper for generation; the summer, noon, and manhood, are proper for preservation; and autumn, evening, and old age, are not unfitly likened to destruction.

* See Vigils *of Plants*.

In order to perpetuate the established course of nature, in a continued series, the Divine Wisdom has thought fit that all living creatures should constantly be employed in *producing* individuals; that all natural things should contribute and lend a helping hand towards *preserving* every species; and lastly, that the *death* and *destruction* of one thing should always be subservient to the production of another. Hence the objects of our present inquiry fall to be considered in a threefold view, that of *propagation*, *preservation*, and *death* or *destruction*.

Sect. II. *The Fossil Kingdom*.

I. Propagation.

It is agreed on all hands, that stones are not organical bodies, like plants and animals; and therefore it is as clear that they are not produced from an egg, like the tribes of the other kingdoms. Hence the variety of fossils is proportionate to the different combinations of coalescent particles, and hence the species in the fossil kingdom are not so distinct as in the other two. Hence also the laws of generation in relation

relation to fossils have been in all ages extremely difficult to explain; and lastly, hence have arisen so many different opinions about them, that it would be endless to enumerate them all. We therefore for the present will content ourselves with giving a very few observations on this subject.

That clay is the sediment of the sea is sufficiently proved by observation, for which reason it is generally found in great plenty along the coasts.

The journals of seamen clearly evince, that a very minute sand covers the bottom of the sea; nor can it be doubted, but that it is daily crystallised out of the water.

It is now acknowledged by all, that testaceous bodies and petrifactions resembling plants were once real animals or vegetables; and it seems likely that shells, being of a calcareous nature, have changed the adjacent clay, sand, or mould, into the same kind of substance. Hence we may be certain that marble may generated from petrifactions; and therefore it is frequently seen full of them.

Rag-stone, the common matter of our rocks, appears to be formed from a sandy kind of clay; but this happens more frequently where the earth is impregnated with iron.

Free-stone is a product of sand; and the deeper the bed where it is found, the more compact it becomes; and the more dense the sand, the more easily it concretes. But if an alkaline clay chances to be mixed with the sand, the free-stone is generated more readily, as in the free-stone called *cos friatilis, particulis argillo-glarensis*.

The flint is almost the only kind of stone, certainly the most common stone, in chalky mountains. It seems therefore to be produced from chalk. Whether it can be reduced again to chalk, is left to others to inquire.

Stalactites, or drop-stone, is composed of calcareous particles, adhering to a dry, and generally a vegetable body.

Incrustations *(Syst. Nat.* 32. 5, 6, 7, 8.) are often generated, where a vitriolic water connects clayey and earthy particles together.

Slate, by the vegetables that are often inclosed in it, seems to take its origin from a marshy mould.

Metals vary according to the nature of the matrix in which they adhere; *e. g.* the pyrites cupri Fahlunensis contains frequently sulphur, arsenic, iron, copper, a little gold, vitriol, alum, sometimes lead-ore, silver, and zinc. Thus gold, copper, iron, zinc, arsenic, pyrites, vitriol, come out of the same vein. That very rich iron-ore at Normark in Vermilandia, where it was cut transversly by a vein of clay, was changed into pure silver. The number therefore of species and varieties of fossils, each serving for different purposes according to their different natures, will be in proportion as the different kinds of earths and stones are variously combined.

II. Preservation.

As fossils are destitute of life and organisation, are hard, and not obnoxious to putrefaction; so they last longer than any other kind of bodies. How far the air contributes to this duration, it is easy to perceive; since air hardens many stones upon the superficies of the earth, and makes them more solid, compact, and able to resist the injuries of time. Thus it is known from vulgar observation, that lime, that has been long exposed to the air, becomes hardened. The chalky marl which they use in Flanders for building houses, as long as it continues in the quarry is friable, but when dug up and exposed to the air it grows gradually harder.

However ignorant we may be of the cause why large rocks are every-where to be seen split, whence vast fragments are frequently torn off; yet this we may observe, that fissures are closed up by water, which gets between them, and is detained there, and are consolidated by crystal and spar. Hence we scarcely ever find any crystal, but in those stones which have retained for some time in its chinks water loaded with stony particles. In the same manner crystals fill the cavities in mines, and concrete into quartz or a debased crystal.

It is manifest that stones are not only generated, augmented, and changed perpetually, from incrustatations brought upon moss, but are also increased by crystal, and spar. Not to mention that the adjacent earth, especially if it be impregnated with iron particles, is commonly changed into a solid stone.

It is said, that the marble quarries in Italy, from whence fragments are cut, grow up again. Ores grow by little and little, whenever the mineral particles, conveyed by the means of water through the clefts of mountains, are retained there; so that, adhering to the homogeneous matter a long while, at last they take its nature, and are changed into a similar substance.

II. Destruction.

Fossils, although they are the hardest of bodies, yet are found subject to the laws of destruction, as well as all other created substances. For they are dissolved in various ways by the elements exerting their force upon them; as by water, air, and the solar rays; as also by the rapidity of rivers, violence of cataracts, and eddies, which continually beat upon, and at last reduce to powder the hardest rocks. The agitations of the sea, and lakes, and the vehemency of the waves, excited by turbulent winds, pulverise stones, as evidently appears by their roundness along the shore. Nay, as the poet says,

> The hardest stone insensibly gives way
> To the soft drops that frequent on it play.

So that we ought not to wonder, that these very hard bodies moulder away into powder, and are obnoxious like others to the consuming tooth of time.

Sand is formed of free-stone, which is destroyed partly by frost, making it friable; partly by the agitation of water and waves, which easily wear away, dissolve, and reduce into minute particles, what the frost had made friable.

Chalk is formed of rough marble, which the air, the sun, and the winds, have dissolved.

The slate-earth, or humus schisti, (Syst. Nat. 512.) owes its origin to slate, showers, air, and snow melted.

Ochre is formed of metals dissolved, whose fæces present the very same colours which we always find the

the ore tinged with when expoſed to the air. Vitriol in the ſame manner mixes with water from ore deſtroyed.

The muria ſaxatilis, *(Syſ. Nat.* 14. 6.) a kind of talky ſtone, yielding ſalt in the parts that are turned to the ſun, is diſſolved into ſand, which falls by little and little upon the earth, till the whole is conſumed; not to mention other kinds of foſſils. Laſtly, from theſe there ariſe new foſſils, as we mentioned before; ſo that the deſtruction of one thing ſerves for the generation of another.

Teſtaceous worms ought not to be paſſed over on this occaſion, for they eat away the hardeſt rocks. That ſpecies of ſhell-fiſh called the *razor-ſhell* bores through ſtones in Italy, and hides itſelf within them; ſo that the people who eat them are obliged to break the ſtones before they can come at them. The cochlea, *(Faun. Suec.* 1299.) a kind of ſnail that lives on craggy rocks, eats and bores through the chalky hills, as worms do through wood. This is made evident by the obſervations of the celebrated de Geer.

Sect. III. *The Vegetable Kingdom.*

I. Propagation.

Anatomy abundantly proves, that all plants are organic and living bodies; and that all organic bodies are propagated from an egg has been ſufficiently demonſtrated by the induſtry of the moderns. We therefore the rather, according to the opinion of the ſkilful, reject the equivocal generation of plants; and the more ſo, as it is certain that every living thing is produced from an egg. Now the ſeeds of vegetables are called *eggs;* theſe are different in every different plant, that the means being the ſame, each may multiply its ſpecies, and produce an offspring like its parent. We do not deny, that very many plants puſh forth from their roots freſh offsets for two or more years. Nay, not a few plants may be propagated by branches, buds, ſuckers, and leaves, fixed in the ground, as likewiſe many trees. Hence their ſtems being divided into branches, may be looked on as roots above ground; for in the ſame way the roots creep under ground, and divide into branches. And there is the more reaſon for thinking ſo, becauſe we know that a tree will grow in an inverted ſituation, viz. the roots being placed upwards, and the head downwards, and buried in the ground; for then the branches will become roots, and the roots will produce leaves and flowers. The lime-tree will ſerve for an example, on which gardeners have chiefly made the experiment. Yet this by no means overturns the doctrine, that all vegetables are propagated by ſeeds; ſince it is clear that in each of the foregoing inſtances nothing vegetates but what was the part of a plant, formerly produced from ſeed; ſo that, accurately ſpeaking, without ſeed no new plant is produced.

Thus again plants produce ſeeds; but they are entirely unfit for propagation, unleſs fecundation precedes, which is performed by an intercourſe between different ſexes, as experience teſtifies. Plants therefore muſt be provided with organs of generation; in which reſpect they hold an analogy with animals. Since in every plant the flower always precedes the fruit, and the fecundated ſeeds viſibly ariſe from the fruit; it is evident that the organs of generation are contained in the flower, which organs are called *antheræ* and *ſtigmata*, and that the impregnation is accompliſhed within the flower. This impregnation is performed by means of the duſt of the antheræ falling upon the moiſt ſtigmata, where the duſt adheres, is burſt, and ſends forth a very ſubtle matter, which is abſorbed by the ſtyle, and is conveyed down to the rudiments of the ſeed, and thus renders it fertile. When this operation is over, the organs of generation wither and fall, nay a change in the whole flower enſues. We muſt however obſerve, that in the vegetable kingdom one and the ſame flower does not always contain the organs of generation of both ſexes, but oftentimes the male organs are on one plant, and the female on another. But that the buſineſs of impregnation may go on ſucceſsfully, and that no plant may be deprived of the neceſſary duſt, the whole moſt elegant apparatus of the antheræ and ſtigmata in every flower is contrived with wonderful wiſdom.

For in moſt flowers the ſtamina ſurround the piſtils, and are of about the ſame height: but there are many plants in which the piſtil is longer than the ſtamina; and in theſe it is wonderful to obſerve, that the Creator has made the flowers recline, in order that the duſt may more eaſily fall into the ſtigma; *e.g.* in the campanula, cowſlip, &c. This curious phenomenon did not eſcape the poetical eye of Milton, who deſcribes it in the following enlivened imagery:

> With cowſlips wan, that hang the penſive head.

But when the fecundation is completed, the flowers riſe again, that the ripe ſeeds may not fall out before they are diſperſed by the winds. In other flowers, on the contrary, the piſtil is ſhorter, and there the flowers preſerve an erect ſituation; nay, when the flowering comes on, they become erect, though before they were drooping, or immerſed under water. Laſtly, whenever the male flowers are placed below the female ones, the leaves are exceedingly ſmall and narrow, that they may not hinder the duſt from flying upwards like ſmoke; as we ſee in the pine, fir, yew, ſea-grape, juniper, cypreſs, &c. And when in one and the ſame ſpecies one plant is male and the other female, and conſequently may be far from one another, there the duſt, without which there is no impregnation, is carried in abundance by the help of the wind from the male to the female; as in the whole dioicous claſs. Again, a more difficult impregnation is compenſated by the longevity of the individuals, and the continuation of life by buds, ſuckers, and roots; ſo that we may obſerve every thing moſt wiſely diſpoſed in this affair. Moreover, we cannot without admiration obſerve that moſt flowers expand themſelves when the ſun ſhines forth; whereas when clouds, rain, or the evening comes on, they cloſe up, leſt the genital duſt ſhould be coagulated, or rendered uſeleſs, ſo that it cannot be conveyed to the ſtigmata. But what is ſtill more remarkable and wonderful, when the fecundation is over, the flowers, neither upon ſhowers, nor evening coming on, cloſe themſelves up. Hence when rain falls in the flowering time, the huſbandman and gardener foretel a ſcarcity of fruits. To mention only one particular more: The organs of generation, which in the animal kingdom are by nature generally removed from ſight, in the vegetable are expoſed to the eyes

Vid. a Treatiſe publiſhed in *Amœn. Acad.* vol. entitled, *Sponſalia Plantarum.*

eyes of all; and that when their nuptials are celebrated, it is wonderful what delight they afford to the spectator by their most beautiful colours and delicious odours. At this time bees, flies, and other insects, suck honey out of their nectaries, not to mention the humming bird; and that from their effête dust the bees gather wax.

2. As to the dissemination of seeds after they come to maturity, it being absolutely necessary, since without it no crop could follow, the Author of nature has wisely provided for this affair in numberless ways. The stalks and stems favour this purpose; for these raise the fruit above the ground, that the winds, shaking them to and fro, may disperse far off the ripe seeds. Most of the pericarpies are shut at top, that the seeds may not fall before they are shook out by stormy winds. Wings are given to many seeds, by the help of which they fly far from the mother-plant, and oftentimes spread over a whole country. These wings consist either of a down, as in most of the composite-flowered plants; or of a membrane, as in the birch, alder, ash, &c. Hence woods, which happen to be consumed by fire or any other accident, will soon be restored again by new plants disseminated by this means. Many kinds of fruits are endued with a remarkable elasticity, by the force of which the ripe pericarpies throw the seeds to a great distance; as the wood-sorrel, the spurge, the phyllanthus, the dittany. Other seeds or pericarpies are rough, or provided with hooks; so that they are apt to stick to animals that pass by them, and by this means are carried to their holes, where they are both sown and manured by nature's wonderful care: and therefore the plants of these seeds grow where others will not; as hounds-tongue, agrimony, &c.

Berries and other pericarpies are by nature allotted for aliment to animals; but with this condition, that while they eat the pulp they shall sow the seeds: for when they feed upon it, they either disperse them at the same time; or, if they swallow them, they are returned with interest, for they always come out unhurt. It is not therefore surprising, that, if a field be manured with recent mud or dung not quite rotten, various other plants, injurious to the farmer, should come up along with the grain that is sowed. Many have believed that barley or rye has been changed into oats, although all such kinds of metamorphoses are repugnant to the laws of generation; not considering that there is another cause of this phenomenon, *viz.* that the ground perhaps has been manured with horse-dung, in which the seeds of oats, coming entire from the horse, lie hid and produce that grain. The misletoe always grows upon other trees, because the thrush that eats the seeds of it, casts them forth with its dung; and as bird-catchers make their bird-lime of this same plant, and daub the branches of trees with it, in order to catch the thrush, the proverb hence took its rise;

> The thrush, when he befouls the bough,
> Sows for himself the seeds of wo.

It is not to be doubted, but that the greatest part of the junipers also, that fill our woods, are sown by thrushes, and other birds, in the same manner; as the berries, being heavy, cannot be dispersed far by the winds. The cross-bill that lives on the fir-cones, and the hawfinch that feeds on the pine-cones, at the same time sow many of their seeds; especially when they carry the cone to a stone, or trunk of a tree, that they may more easily strip it of its scales. Swine likewise, by turning up the earth, and moles by throwing up hillocks, prepare the ground for seeds in the same manner as the ploughman does.

We pass over many other things which might be mentioned concerning the sea, lakes, and rivers, by the help of which oftentimes seeds are conveyed unhurt to distant countries. A variety of other ways in which nature provides for the dissemination of plants, has been pointed out by Linnæus in an *Oration concerning the augmentation of the habitable earth.* As there is something very ingenious and quite new in the treatise here referred to, we shall, for the sake of those who cannot read the original, add a short abstract of it. His design is to shew that there was only one pair of all living things, created at the beginning. According to the account of Moses, says the author, we are sure that this was the case in the human species; and by the same account we are informed that this first pair was placed in Eden, and that Adam gave names to all the animals. In order therefore that Adam might be enabled to do this, it was necessary that all the species of animals should be in in paradise; which could not happen unless also all the species of vegetables had been there likewise. This he proves from the nature of their food; particularly in relation to insects, most of which live upon one plant only. Now had the world been formed in its present state, it could not have happened that all the species of animals should have been there. They must have been dispersed over all the globe, as we find they are at present; which he thinks improbable for other reasons which we shall pass over for sake of brevity. To solve all the phenomena, then, he lays down as a principle, That at the beginning all the earth was covered with the sea, unless one island large enough to contain all animals and vegetables. This principle he endeavours to establish by several phenomena, which make it probable, that the earth has been and is still gaining upon the sea, and does not forget to mention fossile shells and plants every where found, which he says cannot be accounted for by the deluge. He then undertakes to shew how all vegetables and animals might in this island have a soil and climate proper for each, only by supposing it to be placed under the equator, and crowned with a very high mountain. For it is well known that the same plants are found on the Swiss, the Pyrenean, the Scots Alps, on Olympus, Lebanon, Ida, as on the Lapland and Greenland Alps. And Tournefort found at the bottom of mount Ararat the common plants of Armenia, a little way up those of Italy, higher those which grow about Paris, afterwards the Swedish plants, and lastly on the top the Lapland Alpine plants; and I myself, adds the author, from the plants growing on the Dalecarlian Alps could collect how much lower they were than the Alps of Lapland. He then proceeds to shew how from one plant of each species the immense number of individuals now existing might arise. He gives some instances of the surprising fertility of certain plants; *v. g.* the elecampane, one plant of which produced 3000 seeds; of spelt, 2000; of the sun-flower, 4000; of the poppy, 3200; of tobacco, 40,320. But supposing any annual plant producing yearly only two seeds,

Vegetable Kingdom.

feeds, even of this, after 20 years, there would be 1,048,576 individuals. For they would increafe yearly in a duple proportion, *viz.* 2, 4, 8, 16, 32, &c. He then gives fome inftances of plants brought from America, that are now become common over many parts of Europe. Laftly, he enters upon a detail of the feveral methods which nature has taken to propagate vegetables, which is extremely curious, but too long to infert in this place.

II. Preservation.

1. The great Author and Parent of all things decreed, that the whole earth fhould be covered with plants, and that no place fhould be void, none barren. But fince all countries have not the fame changes of feafons, and every foil is not equally fit for every plant; he therefore, that no place fhould be without fome, gave to every one of them fuch a nature, as might be chiefly adapted to the climate: fo that fome of them can bear an intenfe cold, others an equal degree of heat; fome delight in dry ground, others in moift, &c. Hence the fame plants grow only where there are the fame feafons of the year, and the fame foil.

The Alpine plants live only in high and cold fituations; and therefore often on the Alps of Armenia, Switzerland, the Pyreneans, &c. whofe tops are equally covered with eternal fnows as thofe of the Lapland Alps, plants of the fame kind are found, and it would be in vain to feek for them any where elfe. It is remarkable, in relation to the Alpine plants, that they blow, and ripen their feeds very early, left the winter fhould fteal upon them on a fudden, and deftroy them.

Our northern plants, altho' they are extremely rare every where elfe, yet are found in Siberia, and about Hudfon's bay; as the arbutus, bramble, winter-green, &c.

Plants impatient of cold live within the torrid zones; hence both the Indies, though at fuch a diftance from one another, have plants in common. The Cape of Good Hope, we know not from what caufe, produces plants peculiar to itfelf; as all the mefembryanthema, and almoft all the fpecies of aloes. Graffes, the moft common of all plants, can bear almoft any temperature of air: in which the good providence of the Creator particularly appears; for all over the globe they, above all plants, are neceffary for the nourifhment of cattle; and the fame thing is feen in relation to our moft common grains.

Thus neither the fcorching fun, nor the pinching cold, hinders any country from having its vegetables. Nor is there any foil which does not bring forth many kinds of plants. The pond-weeds, the water-lily, lobelia, inhabit the waters. The fluviales, fuci, confervæ, cover the bottoms of rivers, and fea. The fphagna † fill the marfhes. The brya ‡ clothe the plains. The drieft woods, and places fcarce ever illuminated by the rays of the fun, are adorned with the hypna. Nay, ftones and the trunks of trees are not excepted, for thefe are covered with various kinds of liverwort.

† A kind of mofs.

‡ Another kind of mofs.

The defart, and moft fandy places, have their peculiar trees and plants; and as rivers or brooks are very feldom found there, we cannot without wonder obferve that many of them diftil water, and by that means afford the greateft comfort both to man and beafts that travel there. Thus the tillandfia *, which is a parafitical plant, and grows on the tops of trees in the defarts of America, has its leaves turned at the bafe into the fhape of a pitcher, with the extremity expanded; in thefe the rain is collected, and preferved for thirfty men, birds, and beafts.

* A kind of miffletoe.

The water-tree in Ceylon produces cylindrical bladders, covered with a lid; into thefe is fecreted a moft pure and refrefhing water, that taftes like nectar to men and other animals. There is a kind of cuckow-pint in New France, that, if you break a branch of it, will afford you a pint of excellent water. How wife, how beautiful, is the agreement between the plants of every country, and its inhabitants, and other circumftances!

2. Plants oftentimes by their very ftructure contribute remarkably both to their own prefervation and that of others. But the wifdom of the Creator appears no where more, than in the manner of growth of trees. For as their roots defcend deeper than thofe of other plants provifion is thereby made, that they fhall not rob them too much of nourifhment; and what is ftill more, a ftem not above a fpan in diameter often fhoots up its branches very high; thefe bear perhaps many thoufand buds, each of which is a plant, with its leaves, flowers, and ftipulæ. Now if all thefe grew upon the plain, they would take up a thoufand times as much fpace as the tree does; and in this cafe there would fcarcely be room in all the earth for fo many plants, as at prefent the trees alone afford. Befides, plants that fhoot up in this way are more eafily preferved from cattle by a natural defence; and farther, their leaves falling in autumn cover the plants growing about againft the rigour of the winter, and in the fummer they afford a pleafing fhade, not only to animals, but to plants, againft the intenfe heat of the fun. We may add, that trees, like all other vegetables, imbibe the water from the earth, which water does not circulate again to the root, as the ancients imagined; but being difperfed, like fmall rain, by the tranfpiration of the leaves, moiftens the plants that grow around. Again, many trees bear flefhy fruits of the berry or apple kind, which, being fecure from the attack of cattle, grow ripe for the ufe of man and other animals, while their feeds are difperfed up and down after digeftion. Laftly, the particular ftructure of trees contributes very much to the propagation of infects; for thefe chiefly lay their eggs upon the leaves, where they are fecure from the reach of cattle.

Ever-green trees and fhrubs in the northern parts are chiefly found in the moft barren woods, that they may be a fhelter to animals in the winter. They lofe their leaves only every third year, as their feeds are fufficiently guarded by the moffes, and do not want any other covering. The palms in the hot countries perpetually keep their leaves, for there the feeds ftand in no need of any fhelter whatever.

Many plants and fhrubs are armed with thorns, *e.g.* the buckthorn, floe, carduus, cotton-thiftle, &c. that they may keep off the animals, which otherwife would deftroy their fruit. Thefe at the fame time cover many other plants, efpecially of the annual kind, under their branches. Nay, it has frequently been obferved upon commons where furze grows, that wherever there was a bufh left untouched for years by the commoners, fome tree has fprung up, being fecured by the prickles of that fhrub from the bite of cattle. So that while the adjacent grounds are robbed of all plants by the voracity

voracity of animals, some may be preserved to ripen flowers and fruit, and stock the parts about with seeds, which otherwise would be quite extirpated.

All herbs cover the ground with their leaves, and by their shade hinder it from being totally deprived of that moisture which is necessary to their nourishment. They are moreover an ornament to the earth, especially as leaves have a more agreeable verdure on the upper than the under side.

The mosses which adorn the most barren places, at the same time preserve the lesser plants when they begin to shoot, from cold and drought: As we find by experience in our gardens, that plants are preserved in the same way. They also hinder the fermenting earth from forcing the roots of plants upwards in the spring; as we see happen annually to trunks of trees, and other things put into the ground. Hence very few mosses grow in the warmer climates, as not being so necessary to that end in those places.

The English sea mat-weed, or marran, will bear no soil but pure sand, which nature has allotted to it. Sand, the produce of the sea, is blown by winds oftentimes to very remote parts, and deluges, as it were, woods and fields. But where this grass grows, it frequently fixes the sand, gathers it into hillocks, and thrives so much, that, by means of this alone, at last an entire hill of sand is raised. Thus the sand is kept in bounds, other plants are preserved free from it, the ground is increased, and the sea is repelled by this wonderful disposition of nature.

How solicitous nature is about the preservation of grasses is abundantly evident from hence, that the more the leaves of the perennial grasses are eat, the more they creep by the roots, and send forth offsets. For the Author of nature intended that vegetables of this kind, which have very slender and erect leaves, should be copious, and very thick-set, covering the ground like a carpet; and thus afford food sufficient for so vast a quantity of grazing animals. But what chiefly increases our wonder is, that although the grasses are the principal food of such animals, yet they are forbid as it were to touch the flower and seed-bearing stems, that so the seeds may ripen and be sown.

The caterpillar or grub of the moth, although it feeds upon grasses, to the great destruction of them in meadows, yet it seems to be formed in order to keep a due proportion between these and other plants: for grasses, when left to grow freely, increase to that degree, that they exclude all other plants; which would consequently be extirpated, unless this insect sometimes prepared a place for them. Hence always more species of plants appear in those places where this caterpillar has laid waste the pastures the preceding year, than at any other time.

III. Destruction.

Daily experience teaches us, that all plants, as well as all other living things, must submit to death.

They spring up, they grow, they flourish, they ripen their fruit, they wither, and at last, having finished their course, they die, and return to the dust again, from whence they first took their rise. Thus all black mould, which every where covers the earth, for the greatest part is owing to dead vegetables. For all roots descend into the sand by their branches, and after a plant has lost its stem the root remains; but this too rots at last, and changes into mould. By this means this kind of earth is mixed with sand, by the contrivance of nature, nearly in the same way as dung thrown upon fields is wrought into the earth by the industry of the husbandman. The earth thus prepared offers again to plants from its bosom, what it has received from them. For when seeds are committed to the earth, they draw to themselves, accommodate to their nature, and turn into plants, the more subtile parts of this mould by the co-operation of the sun, air, clouds, rains, and winds; so that the tallest tree is, properly speaking, nothing but mould wonderfully compounded with air and water, and modified by a virtue communicated to a small seed by the Creator. From these plants, when they die, just the same kind of mould is formed as gave birth to them originally; but in such a manner, that it is in greater quantity than before. Vegetables therefore increase the black mould, whence fertility remains continually uninterrupted. Whereas the earth could not make good its annual consumption, unless it were constantly recruited by new supplies.

The crustaceous liverworts are the first foundation of vegetation; and therefore are plants of the utmost consequence in the œconomy of nature, tho' so despised by us. When rocks first emerge out of the sea, they are so polished by the force of the waves, that scarce any herb can find a fixed habitation upon them; as we may observe every where near the sea. But the very minute crustaceous liverworts begin soon to cover these dry rocks, although they have no other nourishment but that small quantity of mould and imperceptible particles which the rain and air bring thither. These liverworts dying at last turn into a very fine earth; on this earth the imbricated liverworts find a bed to strike their roots in. These also die after a time, and turn to mould; and then the various kinds of mosses, *e.g.* the hypna, the brya, polytrica, find a proper place and nourishment. Lastly, these dying in their turn, and rotting, afford such plenty of new-formed mould, that herbs and shrubs easily root and live upon it.

That trees, when they are dry or are cut down, may not remain useless to the world, and lie as it were melancholy spectacles, nature hastens on their destruction in a singular way: first the liverworts begin to strike root in them; afterwards the moisture is drawn out of them; whence putrefaction follows. Then the mushroom kinds find a fit place for nourishment on them, and corrupt them still more. The beetle called the *dermestes*, next makes himself a way between the bark and the wood. The musk-beetle, the copper talc-beetle, and the caterpillar or cossus 812 (*S. N.*) bores an infinite number of holes through the trunk. Lastly, the woodpeckers come, and, while they are seeking for insects, wear away the tree already corrupted; till the whole passes into earth. Such industry does nature use to destroy the trunk of a tree! Nay, trees immersed in water would scarcely ever be destroyed, were it not for the worm that eats ships, which performs this work; as the sailor knows by sad experience.

Thistles, as the most useful of plants, are armed, and guarded by nature herself. Suppose there were a

heap of clay, on which for many years no plant has ſprung up; let the ſeeds of the thiſtle blow there, and grow, the thiſtles by their leaves attract the moiſture out of the air, ſend it into the clay by means of their roots, will thrive themſelves, and afford a ſhade. Let now other plants come hither, and they will ſoon cover the ground. *St Bielke.*

All ſucculent plants make ground fine, of a good quality, and in great plenty; as ſedum, craſſula, aloe, algæ. But dry plants make it more barren, as heath, pines, moſs; and therefore nature has placed the ſucculent plants on rocks, and the drieſt hills.

Sect. IV. *The Animal Kingdom.*

I. Propagation.

1. The generation of animals holds the firſt place among all things that raiſe our admiration when we conſider the works of the Creator; and chiefly that appointment, by which he has regulated the conception of the fœtus, and its excluſion, that it ſhould be adapted to the diſpoſition and way of living of each animal, is moſt worthy of our attention.

We find no ſpecies of animals exempt from the ſtings of love, which is put into them to the end that the Creator's mandate may be executed, *Increaſe and multiply;* and that thus the egg, in which is contained the rudiment of the fœtus, may be fecundated; for without ſecundation all eggs are unfit to produce an offspring.

Foxes and wolves, ſtruck with theſe ſtings, every where howl in the woods; crowds of dogs follow the female; bulls ſhew a terrible countenance, and very different from that of oxen. Stags every year have new horns, which they loſe after rutting time. Birds look more beautiful than ordinary, and warble all day long through laſciviouſneſs. Thus ſmall birds labour to outſing one another, and cocks to outcrow. Peacocks ſpread forth again their gay and glorious trains. Fiſhes gather together, and exult in the water; and graſhoppers chirp, and pipe, as it were, amongſt the herbs. The ants gather again into colonies, and repair to their citadels. We paſs over many other particulars, which this ſubject affords, to avoid prolixity.

2. The ſecundated egg requires a certain and proportionate degree of heat for the expanſion of the ſtamina of the embryo. That this may be obtained, nature operates in different manners; and therefore we find in different claſſes of animals a different way of excluding the fœtus.

The females of quadrupeds have an uterus, contrived for eaſy geſtation, temperate and cheriſhing warmth, and proper nouriſhment of the fœtus, as moſt of them live upon the earth, and are there fed.

Birds, in order to get ſubſiſtence, and for other reaſons, are under a neceſſity of ſhifting place; and that not upon their feet, but wings. Geſtation therefore would be burthenſome to them. For this reaſon they lay eggs, covered with a hard ſhell. Theſe they ſit upon by a natural inſtinct, and cheriſh till the young one comes forth.

The oſtrich and caſſowary are almoſt the only birds that do not obſerve this law; theſe commit their eggs to the ſand, where the intenſe heat of the ſun excludes the fœtus.

Fiſhes inhabit cold waters, and moſt of them have cold blood; whence it happens that they have not heat ſufficient to produce the fœtus. The all-wiſe Creator therefore has ordained, that moſt of them ſhould lay their eggs upon the ſhore; where, by means of the ſolar rays, the water is warmer, and alſo fitter for that purpoſe; becauſe it is there leſs impregnated with ſalt, and conſequently milder; and alſo becauſe water-inſects abound more there, which afford the young fry nouriſhment.

Salmons in the like manner, when they are about to lay their eggs, are led by inſtinct to go up the ſtream, where the water is freſh and more pure.

The butterfly-fiſh is an exception, for that brings forth its fœtus alives.

The fiſhes of the ocean, which cannot reach the ſhores by reaſon of the diſtance, are alſo exempt from this law. The Author of nature has given to this kind eggs that ſwim; ſo that they are hatched amidſt the ſwimming fucus, called *ſargazo**. * *Flor. Zeyl.* 389.

The cetaceous fiſh have warm blood; and therefore they bring forth their young alive, and ſuckle them with their teats.

Many amphibious animals bring forth live fœtuſes, as the viper and the toad, &c. But the ſpecies that lay eggs, lay them in places where the heat of the ſun ſupplies the warmth of the parent.

Thus the reſt of the frog kind, and the lizard kind, lay their eggs in warm waters; the common ſnake in dunghills, and ſuch like warm places; and give them up to nature, as a provident nurſe, to take care of them. The crocodile and ſea-tortoiſes go aſhore to lay their eggs under the ſand, where the heat of the ſun hatches them.

Moſt of the inſect kind neither bear young nor hatch eggs: yet their tribes are the moſt numerous of all living creatures; inſomuch, that if the bulk of their bodies were proportionate to their quantity, they would ſcarce leave room for any other kinds of animals. Let us ſee therefore with what wiſdom the Creator has managed about the propagation of theſe minute creatures. The females by natural inſtinct meet and copulate with the males; and afterwards lay their eggs: but not indiſcriminately in every place. For they all know how to chooſe ſuch places as may ſupply their offspring in its tender age with nouriſhment, and other things neceſſary to ſatisfy their natural wants: for the mother, ſoon after ſhe has laid her eggs, dies; and were ſhe to live, ſhe would not have it in her power to take care of her young.

Butterflies, moths, ſome beetles, weevils, bugs, cuckow-ſpit inſects, gall-inſects, tree-bugs, &c. lay their eggs on the leaves of plants, and every different tribe chooſes its own ſpecies of plant. Nay, there is ſcarce any plant which does not afford nouriſhment to ſome inſect; and ſtill more, there is ſcarcely any part of a plant which is not preferred by ſome of them. Thus one inſect feeds upon the flower; another upon the trunk; another upon the root; and another upon the leaves. But we cannot help wondering particularly, when we ſee how the leaves of ſome trees and plants, after eggs have been let into them, grow into galls; and form dwellings, as it were, for the young ones, where they may conveniently live. Thus when the gall inſect has fixed her eggs in the leaves of an oak, the wound

wound of the leaf fwells, and a knob like an apple arifes, which includes and nourifhes the embryo.

When the tree-bug has depofited its eggs in the boughs of the fir-tree, excrefcences arife fhaped like pearls. When another fpecies of the tree-bug has depofited its eggs in the moufe-ear chickweed or the fpeedwell, the leaves contract in a wonderful manner into the fhape of a head. The water-fpider, excludes eggs either on the extremities of the juniper, which from thence forms a lodging, that looks like the arrow-headed grafs; or on the leaves of the poplar, from whence a red globe is produced. The tree-loufe lays its eggs on the leaves of the black poplar, which upon that turn into a kind of inflated bag; and fo in other inftances. Nor is it upon plants only that infects live and lay their eggs. The gnats commit theirs to ftagnating waters. The water-infect called *monoculus* often increafes fo immenfely on pools, that the red legions of them have the appearance of blood. Others lay their eggs in other places: *e.g.* the beetle, in dunghills; the dermeftes, in fkins; the flefh-fly, in putrified flefh; the cheefe-maggot, in the cracks of cheefe, from whence the caterpillars iffuing forth, oftentimes confume the whole cheefe, and deceive many people, who fancy the worms are produced from the particles of the cheefe itfelf, by a generation called *equivocal*, which is extremely abfurd. Others exclude their eggs upon certain animals. The mill-beetle lays it eggs between the fcales of fifhes; the fpecies of gad-fly, on the back of cattle; the fpecies 1025 (*S. N.*) on the back of the rein-deer; the fpecies 1026, in the nofes of fheep. The fpecies 1028 lodges during the winter in the inteftinal tube, or the throat of horfes, nor can it be driven out till the fummer comes on. Nay, infects themfelves are often furrounded with the eggs of other infects, infomuch that there is fcarcely an animal to be found which does not feed its proper infect, not to fay any more of all the other places where they depofit their eggs. Almoft all the eggs of infects, when laid, are ordained to undergo, by a wonderful law of nature, various metamorphofes, *e.g.* the egg of the butterfly, being laid in the cabbage, firft of all becomes a caterpillar, that feeds upon grafs, crawls, and has 16 feet. This afterwards changes into a nymph, that has no feet, is fmooth, and eats nothing; and laftly, this burfts into a butterfly that flies, has variety of colours, is rough, and lives upon honey. What can be more worthy of admiration than that one and the fame animal fhould appear on the ftage of life under fo many characters, as if it were three diftinct animals. Linnæus, (*Amœn. Academ.* tom. ii.) in a treatife on the wonders relating to infects, fays, "As furprifing as thefe transformations may feem, yet much the fame happens when a chicken is hatched; the only difference is, that this chicken breaks all three coats at once, the butterfly one after another."

The laws of generation of worms are ftill very obfcure; as we find they are fometimes produced by eggs, fometimes by offsets juft in the fame manner as happens to trees. It has been obferved with the greateft admiration, that the polypus or hydra (S. N. 221.) lets down fhoots and live branches, by which it is multiplied. Nay more, if it be cut into many parts, each fegment, put into the water, grows into a perfect animal; fo that the parts which were torn off are reftored from one fcrap.

3. The multiplication of animals is not tied down to the fame rules in all; for fome have a remarkable power of propagating, others are confined within narrower limits in this refpect. Yet in general we find, that nature obferves this order, that the leaft animals, and thofe which are ufeful and ferve for nourifhment to the greateft number of other animals, are endued with a greater power of propagating than others.

Mites, and many other infects, will multiply to a thoufand within the compafs of a very few days; while the elephant fcarcely produces one young in two years.

The hawk kind generally lay not above two eggs, at moft four; while the poultry kind rifes to 50.

The diver, or loon, which is eaten by few animals, lays alfo two eggs; but the duck kind, the moorgame, partridges, &c. and fmall birds, lay a very large number.

If you fuppofe two pigeons to hatch nine times a-year, they may produce in four years 14760 young. They are endued with this remarkable fertility, that they may ferve for food, not only to man, but to hawks and other birds of prey. Nature has made harmlefs and efculent animals fruitful. She has forbid the bird kind to fall fhort of the number of eggs allotted to each fpecies: and therefore, if the eggs which they intend to fit upon be taken away a certain number of times, they prefently lay others in their room; as may be feen in the fwallow, duck, and fmall birds.

II. Preservation.

1. Prefervation follows generation; this appears chiefly in the tender age, while the young are unable to provide for their own fupport. For then the parents, though otherwife ever fo fierce in their difpofition, are affected with a wonderful tendernefs or fenfe of love towards their progeny, and fpare no pains to provide for, guard, and preferve them; and that not by an imaginary law, but one given by the Lord of nature himfelf.

Quadrupeds give fuck to their tender young, and fupport them by a liquor perfectly eafy of digeftion, till their ftomachs are able to digeft, and their teeth are fit to chew, more folid food. Nay, their love toward them is fo great, that they endeavour to repel with the utmoft force every thing which threatens danger or deftruction to them. The ewe, which brings forth two lambs at a time, will not admit one to her teats unlefs the other be prefent and fuck alfo; left one fhould famifh, while the other grows fat.

Birds build their nefts in the moft artificial manner, and line them as foft as poffible, for fear the eggs fhould get any damage. Nor do they build promifcuoufly in any place, but there only where they may quietly lie concealed and be fafe from the attacks of their enemies.

The hanging-bird makes its neft of the fibres of withered plants, and the down of the poplar feeds, and fixes it upon the bough of fome tree hanging over the water, that it may be out of reach.

The diver places its fwimming neft upon the water itfelf, amongft the rufhes. We defignedly pafs over many inftances of the like kind.

Again,

Again, birds fit on their eggs with fo much patience, that many of them choofe to perifh with hunger, rather than expofe the eggs to danger by going to feek for food.

The male rooks and crows, at the time of incubation, bring food to the females.

Pigeons, fmall birds, and other birds which pair, fit by turns; but where polygamy prevails, the males fcarcely take any care of the young.

Moft of the duck kind pluck off their feathers in great quantity, and cover their eggs with them, left they fhould be damaged by the cold when they quit their nefts for the fake of food; and when the young are hatched, who knows not how folicitous they are in providing for them till they are able to fly and fhift for themfelves?

Young pigeons would not be able to make ufe of hard feeds for nourifhment, unlefs the parents were to prepare them in their crops, and thence feed them.

The owl called the *eagle-owl* makes its neft on the higheft precipices of mountains, and in the warmeft fpot, facing the fun; that the dead bodies brought there may by the heat melt into a foft pulp, and become fit nourifhment for the young.

As an exception indeed to this foftering care of animals, may be mentioned the cuckow, which lays its eggs in the neft of other fmall birds, generally the wag-tail, yellow-hammer, or white-throat, and leaves the incubation or prefervation of the young to them. This cuftom of the cuckow is fo extraordinary, and out of the common courfe of nature, that it would not be credible were it not for the teftimony of the moft knowing and curious natural-hiftorians, fuch as Ray, Willoughby, Gefner, Aldrovandus, Ariftotle, &c. But this feeming want of inftinct is accounted for from the ftructure and fituation of its ftomach, which difqualifies it for incubation ‡; and its inftinctive care is ftill confpicuous in providing a proper, though a foreign, nidus for its eggs.

‡ See the article *Cuculus*.

Amphibious animals, fifhes, and infects, which cannot come under the care of their parents, yet owe this to them, that they are put in places where they eafily find nourifhment.

2. As foon as animals come to maturity, and want no longer the care of their parents, they attend with the utmoft labour and induftry, according to the law and œconomy appointed for every fpecies, to the prefervation of their lives. But that fo great a number of them, which occur every-where, may be fupported, and a certain and fixed order may be kept up amongft them, behold the wonderful difpofition of the Creator, in affigning to each fpecies certain kinds of food, and in putting limits to their appetites. So that fome live on particular fpecies of plants, which particular regions and foils only produce: fome on particular animalcula; others on carcafes; and fome even on mud and dung. For this reafon, Providence has ordained that fome fhould fwim in certain regions of the watery element; others fhould fly: fome fhould inhabit the torrid, the frigid, or the temperate zones; and others fhould frequent defarts, mountains, woods, pools, or meadows, according as the food proper to their nature is found in fufficient quantity. By this means there is no terreftrial tract, no fea, no river, no country, but what contains and nourifhes various kinds of animals. Hence alfo an animal of one kind cannot rob thofe of another kind of its aliment; which, if it happened, would endanger their lives or health: and thus the world at all times affords nourifhment to fo many and fo large inhabitants, at the fame time that nothing which it produces is ufelefs or fuperfluous.

It will not be here amifs to produce fome inftances by which it will appear how providentially the Creator has furnifhed every animal with fuch cloathing as is proper for the country where they live, and alfo how excellently the ftructure of their bodies is adapted to their particular way of life; fo that they feem to be deftined folely to the places where they are found.

Monkeys, elephants, and rhinocerofes, feed upon vegetables that grow in hot countries, and therefore therein they have their allotted places. When the fun darts forth its moft fervid rays, thefe animals are of fuch a nature and difpofition, that it does them no manner of hurt; nay, with the reft of the inhabitants of thofe parts, they go naked; whereas, were they covered with hairy fkins, they muft perifh with heat.

On the contrary, the place of rein-deer is fixed in the coldeft part of Lapland, becaufe their chief food is the liverwort, which grows no-where fo abundantly as there; and where, as the cold is moft intenfe, the rein-deer are cloathed, like the other northern animals, with fkins filled with the denfeft hair, by the help of which they eafily defy the keennefs of the winter. In like manner the rough-legged partridge paffes its life in the very Lapland Alps, feeding upon the feeds of the dwarf birch; and, that they may run up and down fafely amidft the fnow, their feet are feathered.

The camel frequents the fandy and burning defarts, in order to get the barren camel's-hay. How wifely has the Creator contrived for him! he is obliged to go through the defarts, where oftentimes no water is found for many miles about. All other animals would perifh with thirft in fuch a journey: but the camel can undergo it without fuffering; for his belly is full of cells, where he referves water for many days. It is reported by travellers, that the Arabians, when in travelling they want water, are forced to kill their camels, and take water out of their bellies that is perfectly good to drink, and not at all corrupted.

The pelican likewife lives in defart and dry places; and is obliged to build her neft far from the fea, in order to procure a greater fhare of heat to her eggs. She is therefore forced to bring water from afar for herfelf and her young; for which reafon Providence has furnifhed her with an inftrument moft adapted to this purpofe: She has a very large bag under her throat, which fhe fills with a quantity of water fufficient for many days; and this fhe pours into the neft, to refrefh her young, and teach them to fwim.

The wild beafts, lions, and tygers, come to this neft to quench their thirft, but do no hurt to the young.

Oxen delight in low grounds, becaufe there the food moft palatable to them grows.

Sheep

Sheep prefer naked hills, where they find a particular kind of grafs called the *feftuca*, which they love above all things.

Goats climb up the precipices of mountains, that they may browfe on the tender fhrubs; and in order to fit them for it, they have feet made for jumping.

Horfes chiefly refort to woods, and feed upon leafy plants.

Nay, fo various is the appetite of animals, that there is fcarcely any plant which is not chofen by fome, and left untouched by others. The horfe gives up the water-hemlock to the goat. The cow gives up the long-leaved water-hemlock to the fheep. The goat gives up the monks-hood to the horfe, &c.; for that which certain animals grow fat upon, others abhor as poifon. Hence no plant is abfolutely poifonous, but only refpectively. Thus the fpurge, that is noxious to man, is a moft wholefome nourifhment to the caterpillar. That animals may not deftroy themfelves for want of knowing this law, each of them is guarded by fuch a delicacy of tafte and fmell, that they can eafily diftinguifh what is pernicious from what is wholefome; and when it happens that different animals live upon the fame plants, ftill one kind always leaves fomething for the other, as the mouths of all are not equally adapted to lay hold of the grafs; by which means there is fufficient food for all. To this may be referred an œconomical experiment well known to the Dutch, that when eight cows have been in a pafture, and can no longer get nourifhment, two horfes will do very well there for fome days; and when nothing is left for the horfes, four fheep will live upon it.

Swine get provifion by turning up the earth; for there they find the fucculent roots, which to them are very delicious.

The leaves and fruits of trees are intended as food for fome animals, as the floth, the fquirrel; and thefe laft have feet given them fit for climbing.

Befides myriads of fifhes, the caftor, the fea-calf, and others, inhabit the water, that they may there be fed; and their hinder-feet are fit for fwimming, and perfectly adapted to their manner of life.

The whole order of the goofe-kind, as ducks, merganfer, &c. pafs their lives in water, as feeding upon water-infects, fifhes, and their eggs. Who does not fee, that attends ever fo little, how exactly the wonderful formation of their beaks, their necks, their feet, and their feathers, fuits their kind of life; which obfervation ought to be extended to all other birds.

The way of living of the fea-fwallow deferves to be particularly taken notice of; for as he cannot fo commodioufly plunge into the water, and catch fifh, as other aquatic birds, the Creator has appointed the fea-gull to be his caterer in the following manner. When this laft is purfued by the former, he is forced to throw up part of his prey, which the other catches; but in the autumn, when the fifhes hide themfelves in deep places, the merganfer fupplies the gull with food, as being able to plunge deeper into the fea. The chief granary of fmall birds is the knot-grafs, that bears heavy feeds, like thofe of the black bindweed. It is a very common plant, not eafily deftroyed, either by the road fide by trampling upon it, or anywhere elfe; and is extremely plentiful after harveft in fields, to which it gives a reddifh hue by its numerous feeds. Thefe fall upon the ground, and are gathered all the year round by the fmall birds. To which we may add, that many fmall birds feed upon the feeds of plantain, particularly linnets. It is generally known that the goldfinch lives upon the feed of thiftles, from which he has its name in Latin and French. Thus bouutiful nature feeds the fowls of the air.

The Creator has taken no lefs care of fome amphibious animals, as the fnake and frog kind; which, as they have neither wings to fly, nor feet to run fwiftly and commodioufly, would fcarcly have any means of taken their prey, were it not that fome animals run, as it were of their own accord, into their mouths. When the rattle-fnake, a native of America, with open jaws fixes his eyes on a bird, fly, or fquirrel, fitting on a tree, they fly down his throat, being rendered ftupid, and giving themfelves up as deftitute of all refuge. How dreadful this ferpent is to other animals will appear by an account we have in a treatife entitled, *Radix Senega*. Where the author (*Amœn. Academ.* tom. 2) fays, one of thefe terrible ferpents got clandeftinely into the houfe of governor Blake at Carolina; where it would have long lain concealed, had it not been that all the domeftic animals, as dogs, hogs, turkeys and fowls, admonifhed the family by their unufual cries, equally fhewing their horror and confternation, their hair, briftles, and crefts, ftanding up an end. On the other hand, we cannot but adore the Creator's great goodnefs towards man, when we confider the rattle which terminates this ferpent's tail: for by means of that we have an opportunity of guarding againft this dreadful enemy; the found warning us to fly; which if we were not to do, and we fhould be wounded by him, the whole body would be turned into a putrid corruption in fix hours, nay fometimes in half an hour.

The limits of this article will not permit us to produce more examples of this kind. But whoever will be at the pains to take ever fo flight a view of the wonderful works of the Author of nature, will readily fee how wifely the plan, order, and fitnefs of things with divine ends, are difpofed.

3. We cannot without the utmoft admiration behold how providently the Creator has acted as to the prefervation of thofe animals which, at a certain time of the year, are by the rigour of the feafon excluded from the neceffaries of life. Thus the bear in the autumn creeps into the mofs which he has gathered, and there lies all winter; fubfifting upon no other nourifhment but his fat, collected during the fummer in the cellulous membrane, and which without doubt, during his faft, circulates through his veffels, and fupplies the place of food; to which perhaps is added that fat juice which he fucks out of the bottom of his feet.

Thehedge-hog, badger, and mole, in the fame manner fill their winter-quarters with vegetables, and fleep during the frofts. The bat feems cold and quite dead all the winter. Moft of the amphibious animals get into dens, or to the bottom of lakes and pools.

In the autumn, as the cold approaches, and infects difappear, fwallows migrate into other climes in fearch of food and a temperature of air more friendly to their

their conſtitution: though the later hatches, or thoſe young birds which are incapable of diſtant flights, ſeek for an aſylum againſt the violence of the cold in the bottom of lakes amongſt the reeds and ruſhes; from whence, by the wonderful appointment of nature, they come forth again. See the article HIRUNDO. The periſtaltic motion of the bowels ceaſes in all theſe animals while they are obliged to faſt; whence the appetite is diminiſhed, and ſo they ſuffer the leſs from hunger. To this head may be referred the obſervation of the celebrated Liſter concerning thoſe animals, That their blood, when let into a baſon, does not coagulate, as that of all other animals; and ſo is no leſs fit for circulation than before.

The moor-fowls work themſelves out-walks under the very ſnow. They moult in the ſummer; ſo that about the month of Auguſt they cannot fly, and are therefore obliged to run into the woods; but then the moor-berries and bilberries are ripe, from whence they are abundantly ſupplied with food. Whereas the young do not moult the firſt ſummer; and therefore, though they cannot run ſo well, are able to eſcape danger by flight.

The reſt of the birds who feed upon inſects migrate every year to foreign regions, in order to ſeek for food in a milder climate; while all the northern parts, where they live well in the ſummer, are covered with ſnow.

By theſe migrations, birds alſo become uſeful to many different countries, and are diſtributed over almoſt all the globe. And it muſt excite our admiration that all of them exactly obſerve the times of coming and going, and that they do not miſtake their way.

Inſects in the winter generally lie hid within their caſes, and are nouriſhed by the ſurrounding liquor like the fœtus of other animals; from whence, at the approach of ſpring, they awake, and fly forth, to the aſtoniſhment of every one.

However, all animals which lie hid in winter do not obſerve theſe laws of faſting. Some provide ſtore-houſes in ſummer and autumn, from which they take what is neceſſary; as mice, jays, ſquirrels, bees.

III. DESTRUCTION.

1. WE have obſerved above, that all animals do not live upon vegetables, but that there are ſome which feed upon certain animalcula. Nay, there are ſome which ſubſiſt only by rapine, and daily deſtroy numbers of the peaceable kind.

Theſe animals are deſtroyed, but in ſuch a manner that the weaker generally are infeſted by the ſtronger in a continued ſeries. Thus the tree-louſe lives upon plants. The fly called *muſca aphidivora* lives upon the tree-louſe; the hornet and waſp-fly, upon the muſca aphidivora; the dragon-fly, upon the hornet and waſp fly; the ſpider, on the dragon-fly; the ſmall birds on the ſpider; and laſtly, the hawk kind on the ſmall birds.

In like manner, the monoculus delights in putrid waters, the knat eats the monoculus, the frog eats the knat, the pike eats the frog, the ſea-calf eats the pike.

The bat and goat-ſucker make their excurſions only at night, that they may catch the moths, which at that time fly about in vaſt quantities.

The woodpecker pulls out the inſects which lie hid in the trunks of trees.

The ſwallow purſues thoſe which fly about in the open air.

The mole purſues worms. The large fiſhes devour the ſmall. Nay, we ſcarcely know an animal which has not ſome enemy to contend with.

Amongſt quadrupeds wild beaſts are moſt remarkably pernicious and dangerous to others, as the hawk kind among birds. But that they may not, by too atrocious a butchery, deſtroy whole ſpecies, even theſe are circumſcribed within certain bounds. Firſt, as to the moſt fierce of all, it deſerves to be noted how few they are in proportion to other animals. Secondly, the number of them is not equal in all countries. Thus France and England breed no wolves, and the northern countries no tigers or lions. Thirdly, theſe fierce animals ſometimes fall upon and deſtroy one another. Thus the wolf devours the fox. The dog infeſts both the wolf and fox; nay, wolves in a body will ſometimes venture to ſurround a bear. The tiger often kills its own male whelps. Dogs are ſometimes ſeized with madneſs, and deſtroy their fellows, or with the mange deſtroy themſelves.

Laſtly, wild beaſts ſeldom arrive at ſo great an age as animals which live on vegetables. For they are ſubject, from their alkaline diet, to various diſeaſes, which bring them ſooner to an end.

But although all animals are infeſted by their peculiar enemies, yet they are often able to elude their violence by ſtratagems and force. Thus the hare often confounds the dog by her windings.

When the bear attacks ſheep and cattle, theſe draw up together for mutual defence. Horſes join heads together, and fight with their heels. Oxen join tails, and fight with their horns.

Swine get together in herds, and boldly oppoſe themſelves to any attack, ſo that they are not eaſily overcome; and it is worth while to obſerve, that all of them place their young, as leſs able to defend themſelves, in the middle, that they may remain ſafe during the battle.

Birds, by their different ways of flying, oftentimes eſcape the hawk. If the pigeon had the ſame way of flying as the hawk, ſhe would hardly ever eſcape his claws.

It deſerves alſo to be remarked, how much ſome animals conſult their ſafety by night. When horſes ſleep in woods, one by turn remains awake, and, as it were, keeps watch. When monkeys in Braſil ſleep upon trees, one of them keeps awake, in order to give the ſign when the tiger creeps towards them; and in caſe the guard ſhould be caught aſleep, the reſt tear him to pieces. Hence the hunting of rapacious animals is not always ſucceſsful, and they are often obliged to labour for a whole day to no purpoſe. For this reaſon the Creator has given them ſuch a nature, that they can bear faſting a long time. Thus the lion lurks in his den many days without famiſhing; and the wolf, when he has once well ſatisfied his hunger, can faſt many weeks without any difficulty.

If we conſider the end for which it pleaſed the Supreme Being to conſtitute ſuch an order of nature, that ſome animals ſhould be, as it were, created only to be miſerably butchered by others, it ſeems that his Pro-

Animal Kingdom.

Providence not only aimed at fuftaining, but alfo keeping a juft proportion amongft all the fpecies; and fo prevent any one of them from increafing too much, to the detriment of men and other animals. For if it be true, as it is moft affuredly, that the furface of the earth can fupport only a certain number of inhabitants, they muft all perifh if the fame number were doubled or tripled.

There are fome viviparous flies which bring forth 2000 young. Thefe in a little time would fill the air, and like clouds intercept the rays of the fun, unlefs they were devoured by birds, fpiders, and many other animals.

Storks and falcons free Egypt from frogs, which, after the inundation of the Nile, cover all the country. The fame birds alfo clear Paleftine of mice. Bellonius on this fubject fays as follows: "The ftorks come to Egypt in fuch abundance, that the fields and meadows are white with them. Yet the Egyptians are not difpleafed with this fight; as frogs are generated in fuch numbers there, that did not the ftorks devour them, they would over-run every thing. Befides, they alfo catch and eat ferpents. Between Belba and Gaza, the fields of Paleftine are often defart on account of the abundance of mice and rats; and were they not deftroyed by the falcons, that come here by inftinct, the inhabitants could have no harveft."

The white fox is of equal advantage in the Lapland Alps; as he deftroys the Norway rats, which are generated there in great abundance, and thus hinders them from increafing too much in proportion, which would be the deftruction of vegetables.

It is fufficient for us, that nothing is made by Providence in vain; and that whatever is made, is made with fupreme wifdom. For it does not become us to pry too boldly into all the defigns of God. Let us not imagine, when thefe rapacious animals fometimes do us mifchief, that the Creator planned the order of nature according to our private principles of œconomy: for the Laplanders have one way of living; the European hufbandman another; the Hottentots and favages a third; whereas the ftupendous œconomy of the Deity is one throughout the globe; and if Providence does not always calculate exactly according to our way of reckoning, we ought to confider this affair in the fame light, as when different feamen wait for a fair wind, every one with refpect to the part he is bound to, who we plainly fee cannot all be fatisfied.

2. The whole earth would be overwhelmed with carcafes and ftinking bodies, if fome animals did not delight to feed upon them. Therefore, when an animal dies, bears, wolves, foxes, ravens, &c. do not lofe a moment till they have taken all away. But if a horfe, *e. g.* dies near the public road, you will find him, after a few days, fwoln, burft, and at laft filled with innumerable grubs of carnivorous flies, by which he is entirely confumed, and removed out of the way, that he may not become a nuifance to paffengers by his poifonous ftench.

When the carcafes of fifhes are driven upon the fhore, the voracious kinds, fuch as the thornback, the hound-fifh, the conger-eel, &c. gather about and eat them. But becaufe the flux and reflux foon change the ftate of the fea, they themfelves are often detained in pits, and become a prey to the wild beafts that frequent the fhores. Thus the earth is not only kept clean from the putrefaction of carcafes, but at the fame time, by the œconomy of nature, the neceffaries of life are provided for many animals. In the like manner many infects at once promote their own good, and that of other animals. Thus gnats lay their eggs in ftagnant, putrid, and ftinking waters, and the grubs that arife from thefe eggs clear away all the putrefaction: and this will eafily appear, if any one will make the experiment by filling two veffels with putrid water, leaving the grubs in one, and taking them all out of the other; for then he will foon find the water that is full of grubs pure and without any ftench, while the water that has no grubs will continue ftinking.

Lice increafe in a wonderful manner in the heads of children that are fcabby; nor are they without their ufe, for they confume the redundant humours.

The beetle kind in fummer extract all moift and glutinous matter out of the dung of cattle, fo that it becomes like duft, and is fpread by the wind over the ground. Were it not for this, the vegetables that lie under the dung would be fo far from thriving, that all that fpot would be rendered barren.

As the excrements of dogs is of fo filthy and feptic a nature that no infect will touch them, and therefore they cannot be difperfed by that means, care is taken that thefe animals fhould exonerate upon ftones, trunks of trees, or fome high place, that vegetables may not be hurt by them.

Cats bury their dung. Nothing is fo mean, nothing fo little, in which the wonderful order and wife difpofition of nature do not fhine forth.

Laftly, all thefe treafures of nature, fo artfully contrived, fo wonderfully propagated, fo providentially fupported throughout her three kingdoms, feem intended by the Creator for the fake of man. Every thing may be made fubfervient to his ufe, if not immediately, yet mediately; not fo to that of other animals. By the help of reafon man tames the fierceft animals; purfues and catches the fwifteft; nay, he is able to reach even thofe which lie hid in the bottom of fea.

By the help of reafon, he increafes the number of vegetables immenfely; and does that by art, which nature, left to herfelf, could fcarcely effect. By ingenuity he obtains from vegetables whatever is convenient or neceffary for food, drink, cloathing, medicine, navigation, and a thoufand other purpofes.

He has found the means of going down into the abyfs of the earth, and almoft fearching its very bowels. With what artifice has he learned to get fragments from the moft rocky mountains, to make the hardeft ftones fluid like water, to feparate the ufeful metal from the ufelefs drofs, and to turn the fineft fand to fome ufe! In fhort, when we follow the feries of created things, and confider how providentially one is made for the fake of another, the matter comes to this, that all things are made for the fake of man; and for this end more efpecially, that he, by admiring the works of the Creator, fhould extol his glory, and at once enjoy all thofe things of which he ftands in need, in order to pafs his life conveniently and pleafantly.

CONCLUSION.

THIS subject concerning the works of nature, a very small part of which we have been able to touch upon, is of such importance and dignity, that if it were to be properly treated in all its parts, men would find wherewithal to employ almost all the powers of the mind. Nay, time itself would fail before even the most acute human sagacity would be able to discover the amazing œconomy, laws, and exquisite structure, of the least insect; since, as Pliny observes, nature nowhere appears more herself than in her most minute works.

Summary as it is, however, the preceding view, as it were in a map, of the several parts of nature, their connections and dependencies, may, among other uses, convey an useful lesson, and such an one as the best of us often need to have inculcated.

From a partial consideration of things, we are very apt to criticise what we ought to admire; to look upon as useless what perhaps we should own to be of infinite advantage to us, did we see a little farther; to be peevish where we ought to give thanks; and at the same time to ridicule those who employ their time and thoughts in examining what we were (i. e. some of us most assuredly were) created and appointed to study. In short, we are too apt to treat the Almighty worse than a rational man would treat a good mechanic, whose works he would either thoroughly examine, or be ashamed to find any fault with them. This is the effect of a partial consideration of nature; but he who has the candour of mind and leisure to look farther, will be inclined to cry out,

How wond'rous is this scene! where all is form'd
With number, weight, and measure! all design'd
For some great end! where not alone the plant
Of stately growth; the herb of glorious hue,
Or food-full substance; not the labouring steed;
The herd, and flock, that feed us; not the mine
That yields us stores for elegance, and use;
The sea that loads our table, and conveys
The wanderer man from clime to clime; with all
Those rolling spheres, that from on high shed down
Their kindly influence: not these alone,
Which strike ev'n eyes incurious; but each moss,
Each shell, each crawling insect, holds a rank
Important in the plan of Him who fram'd
This scale of beings; holds a rank, which lost
Would break the chain, and leave behind a gap
Which nature's self would rue. Almighty Being,
Cause and support of all things, can I view
These objects of my wonder, can I feel
These fine sensations, and not think of thee?
Thou who dost thro' th' eternal round of time,
Dost thro' th' immensity of space exist
Alone, shalt thou alone excluded be
From this thy universe? Shall feeble man
Think it beneath his proud philosophy
To call for thy assistance, and pretend
To frame a world, who cannot frame a clod?—
Not to know thee, is not to know ourselves——
Is to know nothing—nothing worth the care
Of man's exalted spirit—all becomes,
Without thy ray divine, one dreary gloom,
Where lurk the monsters of fantastic brains,
Order bereft of thought, uncaus'd effects,
Fate freely acting, and unerring Chance.
Where meanless matter to a chaos sinks,
Or something lower still; for without thee
It crumbles into atoms void of force,
Void of resistance—it eludes our thought.
Where laws eternal to the varying code
Of self-love dwindle. Interest, passion, whim,
Take place of right and wrong: the golden chain
Of beings melts away, and the mind's eye
Sees nothing but the present. All beyond
Is visionary guess—is dream—is death.

THOMSON.

Natural, Naturalization.

NATURAL *Philosophy*, that which considers the powers and properties of natural bodies, and their mutual actions one on another. See PHYSICS.

The business of natural philosophy, says Boerhaave, is to communicate a solid and accurate knowledge of all the bodies in being, and all the affections thereof. Nor can this science be acquired otherwise than by observing, by means of our senses, all the objects which the Author of nature hath made cognizable thereto: hence, the first and principal part of this science is to collect all the manifest and sensible appearances of things, and reduce them into a body of natural history. Now there are two ways of making such observations; the first, when we view things nearly as they happen to turn up, without any design or intervention of our own: in which way no great improvements can be expected in the art, because chance, having here the direction, only exhibits occasional or extemporary properties. The other method is, when, after a thorough acquaintance with bodies, we apply them to other bodies equally known, diligently attending to the result, and observing whether any thing new arises. See EXPERIMENTAL PHILOSOPHY.

NATURALIZATION, in law, the act of naturalizing an alien, or putting him into the condition of a natural-born subject, and entitling him to the rights and privileges thereof. See ALIEN, and DENIZEN.

Naturals, Nature.

In France, naturalization is the king's prerogative; in England, it is only done by act of parliament.

In France, Swiss, Savoyards, and Scots, need not any naturalization, being reputed regnicoles, or natives.

NATURALS, among physicians, whatever naturally belongs to an animal, in opposition to non-naturals. See NON-NATURALS.

NATURE, according to Mr Boyle, has eight different significations; it being used, 1. For the Author of nature, whom the schoolmen call *Natura Naturans*, being the same with God. 2. By the nature of a thing, we sometimes mean its essence; that is, the attributes which make it what it is, whether the thing be corporeal or not; as when we attempt to define the nature of a fluid, of a triangle, &c. 3. Sometimes we confound that which a man has by nature, with what accrues to him by birth; as when we say, that such a man is noble by nature. 4. Sometimes we take nature for an internal principle of motion; as when we say, that a stone by nature falls to the earth. 5. Sometimes we understand, by nature, the established course of things. 6. Sometimes we take nature for an aggregate of powers belonging to a body,

body, efpecially a living one; in which fenfe phyficians fay, that nature is ftrong, weak, or fpent; or that, in fuch or fuch difeafes, nature left to herfelf will perform the cure. 7. Sometimes we ufe the term *nature* for the univerfe, or whole fyftem of the corporeal works of God; as when it is faid of a phœnix, or chimera, that there is no fuch thing in nature. 8. Sometimes too, and that moft commonly, we exprefs by the word *nature* a kind of femi-deity, or other ftrange kind of being.

If, fays the fame philofopher, I were to propofe a notion of nature, lefs ambiguous than thofe already mentioned, and with regard to which many axioms relating to that word may be conveniently underftood, I fhould firft diftinguifh between the univerfal and the particular nature of things. Univerfal nature I would define to be the aggregate of the bodies that make up the world in its prefent ftate, confidered as a principle; by virtue whereof they act and fuffer, according to the laws of motion prefcribed by the Author of all things. And this makes way for the other fubordinate notion; fince the particular nature of an individual confifts in the general nature applied to a diftinct portion of the univerfe; or, which is the fame thing, it is a particular affemblage of the mechanical properties of matter, as figure, motion, &c.

Kingdoms of NATURE. See KINGDOMS.

Conduct or Operations of NATURE. See NATURAL *Hiftory*.

NAVAL, fomething relating to a fhip; whence,

NAVAL *Architecture*. See SHIP-*Building*.

NAVAL *Camp*, in antiquity, a fortification, confifting of a ditch and parapet on the land-fide, or a wall built in the form of a femi-circle, and extended from one point of the fea to another. This was fometimes defended with towers, and beautified with gates, through which they iffued forth to attack their enemies. Homer hath left us a remarkable defcription of the Grecian fortifications of this fort, in the Trojan war, beginning at v. 436. Iliad η.

> Then, to fecure the camp and naval powers,
> They rais'd embattled walls with lofty tow'rs:
> From fpace to fpace were ample gates around,
> For paffing chariots; and a trench profound,
> Of large extent; and deep in earth below
> Strong piles infix'd ftood adverfe to the foe.
>
> POPE's *Tranfl.*

Towards the fea, or within it, they fixed great pales of wood, like thofe in their artificial harbours; before thefe the veffels of burden were placed in fuch order, as that they might be inftead of a wall, and give protection to thofe within; in which manner Nicias is reported by Thucydides to have encamped himfelf: but this feems only to have been practifed when the enemy was thought fuperior in ftrength, and raifed great apprehenfions of danger in them. When their fortifications were thought ftrong enough to defend them from the affaults of enemies, it was frequent to drag their fhips to fhore, which the Greeks called ἑνωλκειν, the Romans *fubducere*. Around the fhips the foldiers difpofed their tents, as appears every where in Homer: but this feems only to have been practifed in winter, when their enemy's fleet was laid up and could not affault them; or in long fieges, and when they lay in no danger from their enemies by fea; as in the Trojan war, where the defenders of Troy never once attempted to encounter the Grecians in a fea-fight.

The adjacent places were ufually filled with inns and ftews, well ftocked with females, that proftituted themfelves to the mariners, merchants, and artificers of all forts, who flocked thither in great numbers; this, however, appears to be only in times of peace.

NAVAL *Crown*, among the ancient Romans, a crown adorned with figures of prows of fhips, conferred on perfons who in fea-engagements firft boarded the enemy's veffel. See CROWN.

NAVAL *Engagement*. See NAVAL *Tactics*, chap. vii.

NAVAL *Stores*, comprehend all thofe particulars made ufe of, not only in the royal navy, but in every other kind of navigation; as timber and iron for fhipping, pitch, tar, hemp, cordage, fail-cloth, gunpowder, ordnance, and fire-arms of every fort, fhip-chandlery wares, &c.

NAVAL TACTICS;

Or, The Military Operations of Fleets.

NAVAL TACTICS is the art of ranging fleets in fuch order or difpofition, as may be judged moft convenient, either for attacking, defending, or retreating to the greateft advantage; and to regulate their feveral movements accordingly: it is not a fcience eftablifhed on principles abfolutely invariable, but founded on fuch reafons as the alteration and improvement of arms muft neceffarily occafion in a courfe of time and experience; from which alfo will naturally refult a difference in the conftruction of fhips, in the manner of working them, and, in fine, in the total difpofition and regulation of fleets and fquadrons. We fhall curforily run through this fucceffion and change of arms, &c. to the prefent improvement of our lines of battle, in order to make us the more fenfible of the reafons which have induced the moderns to prefer fo advantageous a choice as they now follow in the arrangement of their fhips.

The ancient galleys were fo conftructed as to carry feveral banks of oars, very differently difpofed from thofe in our modern galleys, which, however, vary the leaft of any others from their ancient model. Advanced by the force of their oars, the galleys ran violently aboard of each other, and by the mutual encounter of their beaks and prows, and fometimes of their fterns, endeavoured to dafh in pieces or fink their enemies.

The prow, for this purpofe, was commonly armed with a brazen point or trident, nearly as low as the furface of the fea, in order to pierce the enemy's fhips under the water. Some of the galleys were furnifhed

with large turrets, and other acceffions of building, either for attack or defence. The foldiers alfo annoyed their enemies with darts and flings, and, on their nearer approach, with fwords and javelins; and in order that their miffive weapons might be directed with greater force and certainty, the fhips were equipped with feveral platforms, or elevations above the level of the deck. The fides of the fhip were fortified with a thick fence of hides, which ferved to repel the darts of their adverfaries, and to cover their own foldiers, who thereby annoyed the enemy with greater fecurity.

As the invention of gun-powder has rendered ufelefs many of the machines employed in the naval wars of the ancients, the great diftance of time has alfo configned many of them to oblivion: fome few are, neverthelefs, recorded in ancient authors, of which we fhall endeavour to prefent a fhort defcription. And firft,

The Δελφιν was a large and maffy piece of lead or iron, caft in the form of a dolphin. This machine being fufpended by blocks at their maft-heads or yard-arms, ready for a proper occafion, was let down violently from thence into the adverfe fhips; and either penetrated through their bottom, and opened a paffage for the entering waters, or by its weight immediately funk the veffel.

The Δρηπαναν was an engine of iron crooked like a fickle, and fixed on the top of a long pole. It was employed to cut afunder the flings of the fail-yards, and, thereby letting the fails fall down, to difable the veffel from efcaping, and incommode her greatly during the action. Similar to this was another inftrument, armed at the head with a broad two-edged blade of iron, wherewith they ufually cut away the ropes that faftened the rudder to the veffel.

Δοραλα ναυμαχα, a fort of fpears or maces of an extraordinary length, fometimes exceeding 20 cubits, as appears by the 15th Iliad of Homer, by whom they are alfo called *μακρα*.

Κιραιαι were certain machines ufed to throw large ftones into the enemy's fhips.

Vegetius mentions another engine, which was fufpended to the main-maft, and refembled a battering-ram; for it confifted of a long beam and an head of iron, and was with great violence pufhed againft the fides of the enemy's galleys.

They had alfo a grappling-iron, which was ufually thrown into the adverfe fhip by means of an engine: this inftrument facilitated the entrance of the foldiers appointed to board, which was done by means of wooden bridges, that were generally kept ready for this purpofe in the fore-part of the veffel. See the article Corvus.

The arms ufed by the ancients rendered the difpofition of their fleets very different, according to the time, place, and circumftances. They generally confidered it an advantage to be to windward, and to have the fun fhining directly on the front of their enemy. The order of battle chiefly depended on their power of managing the fhips, or of drawing them readily into form; and on the fchemes which their officers had concerted. The fleet being compofed of rowing-veffels, they lowered their fails previous to the action; they prefented their prows to the enemy, and advanced againft each other by the force of their oars. Before they joined battle, the admirals went from fhip to fhip, and exhorted their foldiers to behave gallantly. All things being in readinefs, the fignal was difplayed by hanging out of the admiral's galley a gilded fhield, or a red garment or banner. During the elevation of this, the action continued; and by its depreffion, or inclination towards the right or left, the reft of the fhips were directed how to attack or retreat from their enemies. To this was added the found of trumpets; which began in the admiral's galley, and continued round the whole navy. The fight was alfo begun by the admiral's galley, by grappling, boarding, and endeavouring to overfet, fink, or deftroy the adverfary, as we have above defcribed. Sometimes, for want of grappling-irons, they fixed their oars in fuch a manner as to hinder the enemy from retreating. If they could not manage their oars as dextroufly as their antagonift, or fall alongfide fo as to board him, they penetrated his veffel with the brazen prow. The veffels approached each other as well as their circumftances would permit, and the foldiers were obliged to fight hand to hand, till the battle was decided: nor indeed could they fight otherwife with any certainty, fince the fhorteft diftance rendered their flings and arrows, and almoft all their offenfive weapons, ineffectual, if not ufelefs. The fquadrons were fometimes ranged in two or three right lines, parallel to each other; being feldom drawn up in one line, unlefs when formed into an half-moon. This order indeed appears to be the moft convenient for rowing veffels that engage by advancing with their prows towards the enemy. At the battle of Ecnomus, between the Romans and the Carthaginians, the fleet of the former was ranged into a triangle, or a fort of wedge in front, and towards the middle of its depth, of two right parallel lines. That of the latter was formed into a rectangle, or two fides of a fquare, of which one branch extended behind, and as the opening of the other profecuted the attack, was ready to fall upon the flank of fuch of the Roman galleys as fhould attempt to break their line. Ancient hiftory has preferved many of thefe orders, of which fome have been followed in later times. Thus, in a battle A. D. 1340, the Englifh fleet was formed in two lines, the firft of which contained the larger fhips, the fecond confifted of all the fmaller veffels, ufed as a referve to fupport the former whenever neceffary. In 1545, the French fleet under the command of the Marefchal d'Annebault, in an engagement with the Englifh in the Channel, was arranged in the form of a crefcent. The whole of it was divided into three bodies, the centre being compofed of 36 fhips, and each of the wings of 30. He had alfo many galleys; but thefe fell not into the line, being defigned to attack the enemy occafionally. This laft difpofition was continued down to the reigns of James I. and Lewis XIII.

Meanwhile the invention of gunpowder, in 1330, gradually introduced the ufe of fire-arms into naval war, without finally fuperfeding the ancient method of engagement. The Spaniards were armed with cannon in a fea-fight againft the Englifh and the people of Poitou abreaft of Rochelle in 1372; and this battle is the firft wherein mention is made of artillery in our navies. Many years elapfed before the marine armaments were fufficiently provided with fire-arms. So great a revolution in the manner of fighting, and which ne-

neceſſarily introduced a total change in the conſtruction of ſhips, could not be ſuddenly effected. In ſhort, the ſquadrons of men of war are no longer formed of rowing veſſels, or compoſed of galleys and ſhips of the line; but entirely of the latter, which engage under ſail, and diſcharge the whole force of their artillery from their ſides. Accordingly, they are now diſpoſed in no other form than that of a right line parallel to the enemy; every ſhip keeping cloſe-hauled upon a wind on the ſame tack. Indeed, the difference between the force and manner of fighting of ſhips and galleys rendered their ſervice in the ſame line incompatible. When we conſider therefore the change introduced, both in the conſtruction and working of ſhips, occaſioned by the uſe of cannon, it neceſſarily follows, that ſquadrons of men of war muſt appear in the order that is now generally adopted.

The machines which owe their riſe to the invention of gun-powder have now totally ſupplanted the others; ſo that there is ſcarce any but the ſword remaining, of all the weapons uſed by the ancients. Our naval battles are therefore almoſt always decided by fire-arms, of which there are ſeveral kinds, known by the general name of *artillery*.

In a ſhip of war, fire-arms are diſtinguiſhed into cannon mounted on carriages, ſwivel-cannon, grenadoes, and muſquetry. See Cannon, &c.

Beſides theſe machines, there are ſeveral other uſed in merchant-ſhips and privateers, as coehorns, carabines, fire-arrows, organs, ſtink-pots, &c. See Coehorn, &c.

Chap. I. *Of Lines or Orders.*

By orders are meant the different methods of ranging or drawing up a fleet in the ſeveral lines and forms for which it may be deſigned: in which two things are to be conſidered, 1. The poſition of each ſhip with regard to the wind: 2. The poſition of each ſhip with reſpect to the fleet. We cannot make any alteration in either of theſe circumſtances, without changing the whole poſition of the line, which will otherwiſe remain complete.

The different expeditions an admiral may be ordered upon, as well as the various circumſtances that occur in conducting a fleet, firſt gave riſe to the ſeveral lines or orders into which it is formed.

When a fleet engages, it ought to be drawn up in a different form from that in which it ſails. A fleet that ſails in ſight of an enemy muſt alter its poſition, from that which it would maintain were there none in view, or none to be expected. When a fleet ſails before the wind, it has likewiſe its particular form of ſailing; as it has alſo when it chaces the enemy, makes a retreat, guards a ſtreight or paſſage, or is obliged to force through one; or whether at anchor in a road or harbour, or going into either to inſult or attack an enemy. In this variety of circumſtances, proper regard muſt be had to the moſt advantageous poſition or form into which the fleet can be ranged before it enters upon action.

Chap. II. *Of dividing a Fleet, and of the Form of Sailing.*

1. *How to divide a fleet.* When a fleet conſiſts of 60 ſail of the line, the admiral divides it firſt into three ſquadrons, each of which has its diviſions; and three general officers, *viz.* admiral, vice-admiral, and rear-admiral. Each ſquadron has its proper colours, and each diviſion its proper maſt: for example, the white flag is proper to the firſt ſquadron of France, the white and blue for the ſecond, and the blue for the third. In Britain, the firſt admiral of the fleet carries the union-flag at the main-top-maſt head; next, the admiral of the white; and then the admiral of the blue. The particular ſhips carry pendants of the ſame colour with their ſquadrons, and at the maſts of their reſpective diviſions; ſo that the laſt ſhip in the diviſion of the blue ſquadron wears a blue pendant at the mizen top-maſt head.

The general officers, or commanders of diviſions, place themſelves in the centre of their diviſions. We muſt except the three commanding admirals, who in a ſailing poſition lead their reſpective ſquadrons.

2. *The ſailing form of a Fleet.* The following is judged the beſt, and is that which is put in practice upon moſt occaſions, whether upon expeditions, looking out for an enemy, &c. It conſiſts in dividing the fleet into three columns, or parallel lines, either upon a wind or large, as the admiral may think moſt expedient. Thus will the courſe and diſtance of the columns, as well as each ſhip's ſtation, be determined and regulated; obſerving at the ſame time that they keep abreaſt of each other as near as poſſible.

By this manner of ſailing, the fleet is cloſed as much as poſſible, can better obſerve the proper ſignals, and is ready to be ranged or formed into any poſition or line that the admiral ſhall judge proper. In ſailing, care muſt be taken to preſerve the juſt diſtance between the columns; in order to which, it will be beſt for the ſhips in general to regulate themſelves by ſome of the centre ſhips of the column to windward, rather than the ſternmoſt, as they are often too far in their rear to follow their motions.

The moſt natural courſe in this order of ſailing is to go neareſt upon a wind on either tack, or to go away large three or four points: however, the fleet may ſteer away more or leſs from the wind, or even right afore it, as may be judged moſt expedient.

In all forms of ſailing, the tranſports, tenders, &c. are ordered to keep to windward, for the following reaſons. 1. They are by ſuch a ſituation more out of danger from the enemy, as they can the readier bear down into the body of the fleet to avoid them. 2. They can more expeditiouſly execute the admiral's orders, when neceſſary. 3. They do not delay the fleet by waiting for them, being fitter to make ſail before than upon a wind.

This kind of ſhips ought not to keep farther than half a league, for the ſame reaſons that they are ordered to keep to windward; but we muſt obſerve, that when the fleet is not drawn up in a line or three columns, the fire-ſhips, &c. ought not to be farther diſtant from the men of war than they are from one another.

The ſame reaſons which prevail in placing the fire-ſhips, &c. to windward of a fleet in a ſailing poſture, will equally hold good to place them to leeward when obliged to make a retreat. 1. They are there in leſs danger from the purſuit of an enemy, becauſe they are ſur-

Of Chacing. ſurrounded by the fleet to guard them, in the form of a half-moon, from any attack that may be made upon them. 2. The fleet going large in this form, theſe ſmall ſhips may ſhorten ſail to wait for orders. 3. If the fleet ſhould be obliged to reſume the line of battle again to engage the enemy, they will ſtill be in the beſt poſition to ſail in.

In the order of retreat, the ſtore-ſhips, &c. keep themſelves at a greater diſtance than in any other form, 1. That they may not retard the progreſs of the fleet. 2. When the fleet forms again into a line of battle, they may keep better the proper diſtance required.

The fire-ſhips, &c. of the fleet to leeward ought to keep themſelves a little a-head of thoſe ſhips whoſe orders they are to follow; to the end that they may be the readier to join them upon occaſion.

Chap. III. *Of Chacing.*

Plate CXCVI. fig. 1. 1. *To chace with the greateſt advantage.* If the ſhip that chaces is a great way to leeward of the chace, ſhe ſhould continue on the ſame board, till ſhe can tack upon her: that is to ſay, arriving at the point E, ſhe will find the chace at the point F; ſo that the angle FED will make four points, or 45°.

The above method is thought to be the beſt by the moſt experienced ſeamen; becauſe by working in this manner you keep nigher the chace, and by making two tacks you will fetch her wake.

2. The ſhip D may continue on the ſame tack, till ſhe entirely cuts off the chace C; but then ſhe runs the riſk of loſing ſight of her, by continuing too long upon the ſame tack: a fog, a ſhift of wind, a headland, night coming on, and many other incidents that frequently happen at ſea, may give the chace an opportunity of eſcaping, by altering her courſe, &c. therefore we ſhould never put this method in practice, but when very near her, or when we chaſe a friend in order to join him.

Fig. 2. 3. If the ſhip A chaſing the ſhip B to windward, is at a very great diſtance, ſhe muſt continue on the ſame tack till ſhe gets upon her beam; then the ſhip A will tack, and ſtand on again the ſame with the chace, till ſhe brings the ſhip B abreaſt of her. She muſt continue on in the ſame manner, tacking every time ſhe gets abreaſt of the chace, till ſhe is no longer apprehenſive of loſing ſight of her. *Note,* This is to be underſtood when the ſhip A is at a very great diſtance from the chace, becauſe that then ſhe would run too great a length from he, were ſhe to continue on the ſame tack till ſhe could fetch the ſhip B: but then again, when the ſhip A is but at a ſmall diſtance from the ſhip B, ſhe would looſe too much time if ſhe were to tack always when ſhe got a-breaſt of the chace.

Fig. 3. 4. We have already obſerved, that if the ſhip B is to leeward of the ſhip A which ſhe chaces, and under no apprehenſion of loſing ſight of her; or becauſe ſhe might not be at any great diſtance from her, or chaces her large, in proper ſettled weather, when the days are long; or that ſhe might be a friend, whom you would willingly join: then the ſhip B ought to continue on the ſame tack with the ſhip A, till ſhe can cut her off upon the other tack.

Now we muſt know how to determine if the ſhip B in tacking will fetch the ſhip A. 1. It is evident, that if the ſhip B, which is ſuppoſed to be a better ſailer than the chace A, continues ſtill on the ſame board Of Chacing. till ſhe gets as far to windward as the ſhip A, ſhe may eaſily intercept her by tacking upon her: this appears, at firſt ſight, as if we ſhould reject this method, becauſe it makes the ſhip B continue on one tack longer than is neceſſary: but ſtill good judges think it ſhould not be entirely rejected, becauſe the ſhip B may thoroughly make up for her loſs of time in continuing on ſo long a-board; for ſhe may then bear down upon the ſhip A as much as ſhe thinks proper, at the ſame time obliging her not to alter her courſe, as was remarked above. 2. The ſhip B will exactly know when ſhe ought to tack upon the chace A, if ſhe calculates the time from her being abreaſt of her till ſhe thinks proper to tack upon her again: for continuing on the ſame length of time, ſhe may be certain ſhe cannot fail of intercepting her.

5. When the admiral would have the whole fleet to chace, or a particular ſquadron only, he will make known the ſame accordingly by hoiſting the uſual ſignal for making ſail, whether his intention be to chace or join ſome ſhips that appear in ſight, or ſtretch out a-head, and make the land. In the firſt caſe, the ſhips ſhould prepare themſelves immediately, that no time may be loſt in wearing or tacking, if occaſion for either. In the ſecond, the headmoſt ſhips ſhould bring to, to ſound, if the coaſt is not thoroughly known to the fleet.

6. The ſquadron that chaces, or the cruiſers detached from the fleet, ſhould be very careful not to engage too far in the chace, for fear of being overpowered; however, not to omit, at the ſame time, thoroughly ſatisfying themſelves with regard to the object of their chace, if poſſible. They muſt pay great attention to the admiral's ſignals at all times, to prevent ſeparation; in order to which, they ſhould collect themſelves before night, eſpecially if there be any appearance of thick or foggy weather coming on; and endeavour to join the fleet again.

7. If the admiral would have the whole fleet to chace, without obſerving any particular form, he will, to avoid confuſion, prepare them accordingly for it by ſignal to look out and watch his motions; to which he will join the general ſignal to chace at large: then the ſhips are immediately to get ready to make ſail, as ſoon as the admiral ſhall think proper to ſignify his orders to chace in any particular quarter, or for any other movement he would have them execute: thus he will be able to inform himſelf (as the ſignal might perhaps be for that purpoſe only) which are the beſt ſailing ſhips, and which the moſt experienced and ſkilful officers in his fleet; all which, with their ſeveral methods of working and ſailing, will give him an opportunity of knowing them more thoroughly, that he may employ them accordingly, whenever the ſervice ſhould require the exertion of their reſpective abilities and experience.

When the admiral would have only a particular ſquadron to chace at pleaſure, he will make a preparatory ſignal for that ſquadron to look out and watch his motions with its diſtinguiſhing flag, and that of chacing at large; but the ſhips are not to begin the chace before the ſignal for the execution of the particular motion is hoiſted at the maſt-head which denotes the ſaid ſquadron.

The

Of Anchoring.

The ſhips are diligently to obſerve when the admiral makes the ſignal to give over chace, that each, regarding the admiral's ſhip as a fixed point, is to work back, or make ſail into her ſtation, to form the order or line again, as expeditiouſly as the nature of the chace and diſtance will permit.

8. After the ſhip has ſignified to the admiral that ſhe expects to come up with the chace, and that, if an enemy, ſhe can attack her to advantage, ſhe muſt be then very attentive to the admiral's ſigns in return, whether of approbation or diſapprobation, which no doubt he will make upon the occaſion, leſt ſhe ſhould unwarily engage too far, and againſt the admiral's orders. On the ſignal of diſapprobation, ſhe muſt abſolutely quit the chace, and return again into the fleet at all events.

9. The ſame ſignal that the admiral makes to give over the engagement, will ſerve at the ſame time for the ſhips to rally or return again to their reſpective ſtations; the commanders of ſquadrons will repeat it, that the ſhips may work properly and with expedition, to form their line as before; each commanding officer with reſpect to the commander in chief, and the reſt of the ſhips with regard to the chiefs of their diviſions or commanders of ſquadrons.

If the action continue till night, the admiral will make the general ſignal for rallying, when each commander of a ſquadron is to make the ſame for his particular ſhips.

Sometimes the ſignal for diſcontinuing the action might regard only a particular part of the fleet, which will be ſignified accordingly by the proper diſtinguiſhing flag of that body or diviſion.

10. *To avoid the chace.* If the ſhip that is chaced be to windward, ſhe muſt keep on the tack on which ſhe finds ſhe gains moſt on the enemy, to keep him at the greateſt diſtance; if to leeward, ſhe will go right before the wind, or more or leſs large, according as ſhe finds either moſt to her advantage, and more agreeable to her particular properties in ſailing or working.

Chap. IV. *Of Anchoring.*

When a fleet comes to an anchor, there are five circumſtances to be conſidered: 1. That the ground be good and holding. 2. That the place be well ſheltered againſt the reigning winds that blow on the coaſt where you anchor. 3. That you may eaſily get under ſail with the ſame wind that may ſerve an enemy, and at the ſame time be able to diſpute the advantage of the wind with them. 4. That you can readily form the line as ſoon as you get under ſail. 5. That the ſhips may have room to keep clear of each other in getting under way: in order to which we ſhould give the ſhips a good birth when we come to anchor, making one or many lines, about three cables length aſunder, and 120 fathom between each ſhip.

Example. It was no doubt by ſuch wiſe precautions that the duke of York ſaved his fleet in Solebay in the year 1672; it was compoſed of 60 Engliſh and 30 French ſhips. His royal highneſs kept the ſea a long time to draw out the Dutch to a deciſive action: but ſeeing they ſtill perſiſted to ſecure themſelves amidſt the banks and ſhoals of their own coaſt, and could not by any means force them to a battle, he took the reſolution of returning to Solebay, to refreſh and recruit his men with proper neceſſaries. Admiral de Ruyter, who commanded the Dutch fleet, thought proper not to let ſlip ſo happy a conjuncture, as he imagined, of ſurpriſing the Engliſh as they lay at an anchor in the road: he accordingly ſet ſail with all his fleet, which was equal to the duke of York's, on the 6th of June, and ſtretched over on the Engliſh coaſt, with the wind at N. E. for Solebay, where he did not doubt but he ſhould meet with the enemy in ſome diſorder and confuſion. But the duke, like an experienced officer, ordered the count d'Etrées, vice-admiral, and afterwards mareſchal of France, who commanded the van, to anchor out in the offing; placing himſelf, with the reſt of his fleet, in ſuch a manner as to enable him to receive the Dutch admiral in a proper poſition, whenever he ſhould be informed of his coming. Upon his appearance, the count d'Etrées formed the line with incredible alertneſs, kept cloſe to the wind, and having ſtretched out the length of the ſquadron of Zealand, commanded by vice-admiral Barker, begun the action the 7th of June at eight in the morning, and fought the enemy with ſuch bravery, that ſeveral of their ſhips were diſabled: he had even made the proper diſpoſition to re-tack, and charge thro' Barker's ſquadron, if the calm which came on had not prevented his glorious deſign. The duke of York was engaged at the ſame time with de Ruyter, whilſt the earl of Sandwich in the rear attacked the Dutch rear-admiral Van Ghent: but the clouds of ſmoke being diſperſed, and the ſhips no longer under command in the calm, the two fleets found themſelves ſo intermixed and embarraſſed with each other, as greatly heightened the horror of the action, and made it the bloodieſt that ever was fought. The gallant earl of Sandwich periſhed with his ſhip, that was ſet on fire by a Dutch fire-ſhip: ſoon after which, his death was revenged by that of the admiral of the Amſterdam ſquadron, and by the loſs of two Dutch line-of-battle ſhips, one of which was taken, and the other ſunk. The duke of York ſhifted his flag twice. In fine, the battle laſted with incredible obſtinacy on both ſides till night, which favoured the retreat of the Dutch: the duke purſued them next day home to their very banks; where, having ſheltered themſelves, they eſcaped a total defeat from the hands of a victorious enemy.

We ſee by the preceding example, how important and neceſſary it is to be always in readineſs to get under ſail to receive an enemy; and we may learn by the following example how dangerous it is to wait for an enemy at anchor.

The mareſchal duke de Vivonne, viceroy of Sicily for the king of France, having intelligence that the enemy, after the engagement off Auguſta, had retired to the port of Palermo, reſolved to go and attack them in the road. He accordingly embarked on board the Sceptre, commanded by M. de Tourville as commodore, who hoiſted an admiral's flag, and arrived the 2d of June 1676 in ſight of Palermo, having 27 ſhips of the line and 25 galleys. He ſent his cruiſers to reconnoitre the poſition of the enemy, who brought him intelligence that they conſiſted of 27 ſhips and 29 galleys; that they lay at anchor in a line, fronting the fort of Caſtel-del-Mar, and under its cannon; and were defended on the right by the grand tower and the

Line of Battle.

the artillery of the ramparts of the city, and on the left by the batteries of the mole. The marquis de Priuli, chef d'efcadre (commodore), was detached with nine fhips and five firefhips, and the chevaliers de Bretevil and Bethormas with feven galleys, to bear down upon the enemy to the left; all which was executed with fo much bravery and refolution, that the vanguard of the enemy were obliged to cut and flip, and run afhore under the batteries of the town; where the firefhips burnt three of their fhips to the water's-edge: the whole was deftroyed by the French with very little lofs.

Chap. V. *Line of Battle.*

I. The ancients, as already obferved, ranged their fhips or galleys fo as to prefent them in front to their enemy; becaufe the machines they then made ufe of were fixed in the heads or prows of their veffels: the fame reafon now prevails with regard to the galleys, (fee the article Galley), which are drawn up in the form of a crefcent or half-moon, whofe ends or horns are oppofed to the enemy; in the middle of which is the admiral, from whence he the more diftinctly obferves the motions of his fleet throughout. The two fleets being thus drawn up, approach each other to a convenient diftance; when the engagement beginning at the ends of the half-moon, they extend themfelves infenfibly till the whole fleet is engaged, and each partakes of the danger and glory of the action. See fig. 4.

Example. The famous battle of Lepanto is the moft remarkable action of this kind that ever happened. It was fought between the Turks and Chriftians in the gulph of Lepanto, the 7th of October 1571. The Chriftian fleet of galleys confifted of 205, large and fmall; the Turks had near 260: both formed two long lines, each inclining towards the end, where they began the engagement. Don John of Auftria, generaliffimo of the Chriftian forces, had placed himfelf in the centre of his fleet, and gave the command of his right wing (van) to the famous admiral Doria, and his left (rear) to Michael Barbarigo. The bafhaw Pertau, general of the Turks, had likewife placed himfelf, together with the bafhaw Ali, in the centre of his fleet: and gave the command of his right wing to the bafhaws of Alexandria, Mehemet and Siroco, and his left to Uluchiali, governor of Algier. The action began at two o'clock in the afternoon; which was firft brought on by rowing towards each other with all their might, accompanied all the time with the moft alarming fhouts and outcries. The left wing of the Chriftians performed wonders: Barbarigo attacked the Turks with fuch incredible fury, that the barbarians could no longer refift the inceffant fire of the Chriftians, but precipitately ran themfelves afhore on the neighbouring coaft, fome plunging into the fea, others leaving their galleys to the bravery and mercy of the conquerors. The defeat was fo general, that the Turks efcaped with only 30 galleys. There perifhed in this day's bloody action 25,000 Turks; 3500 prifoners were taken, and 130 galleys; the Chriftians loft on their fide 10,000 men, and 15 galleys: they might have then deftroyed the whole Ottoman power, had they known how to have made the greateft advantage of fo glorious a victory.

Line of battle.

II. In an engagement of men of war, the fleets are drawn up in a line of battle on two parallel lines upon a wind. The fhips keep clofe to the wind on the line they are formed in, and are commonly at a cable's length diftant one from the other, the firefhips, tranfports, tenders, &c. keeping at half a league's diftance on the oppofite fide of the enemy. Thus the fleets AB, CD, (fig. 5.) that are engaged, are ranged under an eafy fail with their larboard tacks on board; and the firefhips EE of the fleet AB are to windward, the firefhips FF are to leeward of their fleet CD.

Plate CXCVII.

Example. This form was obferved, for the firft time, in the famous battle of the Texel, where the duke of York defeated the Dutch on the 13th of June 1665.

We, as well as the French, owe the entire perfection of this order to his royal highnefs. The Englifh fleet confifted of 100 fhips of the line; that of Holland was more numerous, though not in three-deck fhips: the two fleets found themfelves nigh each other early in the morning, the wind being at S. W. they ranging themfelves in two lines at S. S. E. each extending itfelf about five leagues in length, the Englifh having the advantage of the wind. The duke of York, commander in chief of the Englifh fleet, had placed himfelf in the centre, and gave the command of the van-guard to prince Rupert, and the rear to lord Sandwich. The Dutch admiral Opdam had oppofed himfelf in the centre of his fleet to the duke of York, and vice-admiral Tromp againft prince Rupert. They cannonaded each other from 3 o'clock in the morning till 11, with great fury and intrepidity, the victory ftill declaring for neither fide. The Dutch took one Englifh fhip, which too rafhly attempted to force through their line: but they falling off to S. E. found the Englifh fire greatly annoyed them. About 11 o'clock the duke of York bore down with his whole line upon the enemy, he himfelf bearing down at the fame time upon Opdam: this difpofition and refolution of his royal highnefs elevated the courage and fpirit of both parties to an almoft invincible obftinacy. The terrible roaring of the cannon, wrecks of fhips, fall of mafts, together with a thick fmoke intermixed with flafhes of fire from the fhips that blew up, heightened the horror of this action beyond the power of imagination. It is related of admiral Opdam, that, amidft all this fcene of carnage and deftruction, he fat with the greateft compofure on his poop, viewing, and giving orders to repair as much as poffible the damage and diforder he fuftained from the duke of York; animating his men all the time both by his words and actions. At two o'clock in the afternoon, his royal highnefs made the fignal for the whole line to bear down together upon the enemy; which obliged the Dutch to alter their difpofition of keeping clofe to the wind any longer. Opdam only, with one of his fhips, called the *Prince of Orange*, of three decks, ftill kept his ftation; but foon after, Opdam having received a whole broadfide from the duke of York, his fhip blew up, without its being ever known by what accident, though five of the men were faved. The Dutch, having already loft many of their fhips, and feeing their admiral blow up, put before the wind for the Texel; the duke of York purfuing them with great refolution and bravery to the

Fig. 1.

Fig. 3.

Fig. 2.

Fig. 4.

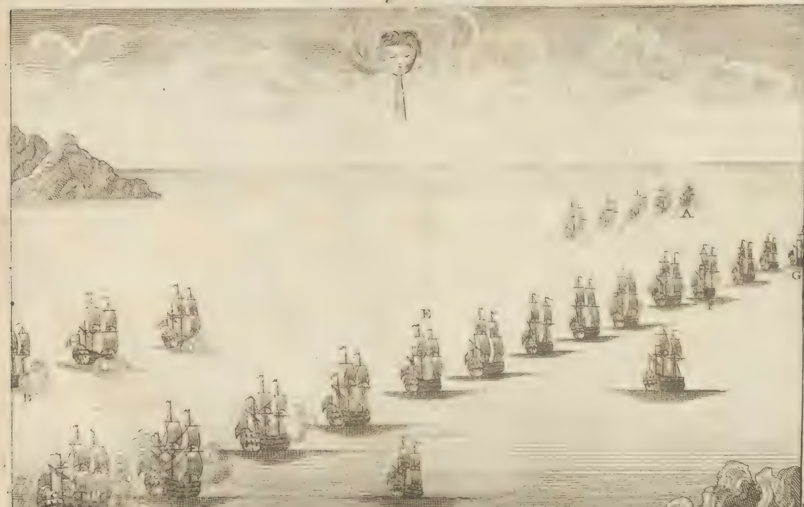
Fig. 1.

Fig. 2.

Fig. 8.

Fig. 9.

Fig. 10.



A.Bell Sculp.

J. Hall sculp.

A Fleet to Windward.

the very entrance of their port: he took, burnt, and deftroyed, 22 fhips of the line, 20 of which were from 50 to 80 guns; and gained over them the moft glorious victory that was ever obtained at fea. The whole action coft him but one man of war, with the lofs of 300 or 400 men.

III. Before we enter into action, or form the line of battle, we muft confider firft the advantages or difadvantages of being to windward or to leeward.

Advantages of being to Windward.

1. The fleet to windward can edge down to the enemy, when and as near as it fhall think convenient: confequently regulates the time and diftance moft advantageous to come to action.

Plate CXCVII. fig. 6.

2. If the fleet to windward is more in number, it may eafily detach fome fhips to fend after the rear of the enemy, which muft undoubtedly throw them into confufion. Thus, the fleet AB being more in number than the fleet CD, may eafily detach the fhips EF to double upon the rear D, which cannot long refift fuch fuperior fire; therefore muft give them an opportunity (with the reft of the fhips that will of courfe join them) to range along the whole length of the enemy's line. This is an advantage the fleet to leeward cannot have, let it be ever fo numerous; for the rear of its line will be in a manner ufelefs.

Example. The advantage of the wind could never be more favourable than it was in an action off Agufta, the 22d of April 1676, when the combined fleets of Spain and Holland avoided a total defeat by having the advantage of the wind. The French fleet, commanded by Monf. Du Quefne, confifted of 27 fhips of the line. The marquis of Almira, lieutenant-general, commanded the van-guard; and Monf. Gabare, chef d'efcadre (commodore), the rear. The enemy's fleet confifted of about the fame number of fhips, but had befides 9 galleys; De Ruyter commanded the van-guard, the Spanifh admiral was in the centre, and the Dutch vice-admiral commanded the rear. The two fleets met off Agufta early in the morning; but the enemy kept their wind till 4 o'clock in the afternoon, when de Ruyter bore down upon the French rear in good order, where they received him in the fame manner with equal intrepidity: there were many fhips difabled on both fides. The marquis d'Almira was carried off by a cannon-ball, and de Ruyter was mortally wounded. Thefe two accidents caufed fome diforder in the van of the fleet; but the chevalier de Vallballe, chef d'efcadre, fupplying the place of the marquis d'Almira, behaved fo remarkably gallant, that he was juft upon the point of taking and deftroying a part of the enemy's fleet, had not their galleys moft opportunely taken their difabled fhips in tow, and faved them from falling into his hands. The action began later in the centre, and had fcarcely reached the rear guard: the enemy having the wind, had availed themfelves fo well of that advantage, that they continued the engagement no longer than was neceffary to fave their honour; waiting for the approaching night to retire from the purfuit of the victors.

3. If any of the fhips of the fleet to leeward fhould be difabled, whether in the van or rear, or even in the centre, the fleet to windward may with the greater eafe fend down their fire-fhips upon them, or fend a detachment after any part of the flying enemy.

A Fleet to Leeward.

4. We muft likewife attribute, amidft other advantages of being to windward, that of being fooner freed from the inconvenience of the fmoke of the enemy as well as of our own. 1. The wind repelling back again the fmoke of the cannon into the fhip, fo greatly incommodes thofe quartered at the guns, as totally to deprive them for fome time of the fight of the enemy. 2. The fame fmoke muft likewife much embarrafs the failors in working the fhip; as it is often found by experience, that the fails and rigging are fet on fire by the combuftible matter and fiery particles incorporated with the fmoke; befides many other fatal accidents incident to fhips in that unhappy fituation.

Advantages of being to Leeward.

It muft be acknowledged, that a fleet to leeward has likewife great advantages; and there are who maintain, that the advantage of being to leeward is at leaft equal to that of being to windward. But when they confider all circumftances more attentively, they will find the advantage of being to windward the greateft a fleet can poffibly have, whether fuperior or inferior to the enemy: though we muft allow at the fame time, that, on fome extraordinary occafions, it may be more adviseable to get to leeward if we can, that is, when it blows hard, and the fea runs fo high, that the weather fleet cannot open its lower tier, when obliged to engage a greater number of fhips, or in an action between two fingle fhips. But ftill, in an engagement between two fleets, in moderate, proper weather for engaging, that which has the weather-gage has greatly the advantage.

1. The fleet to leeward fire to windward, and confequently the fhips may make ufe of their lower tier, without being under any apprehenfions that a fudden fquall of wind fhould overpower them, by the water rufhing in irrefiftably between decks: an advantage (in fome meafure) the Englifh fleet under Sir Edward Hawke, had over the French fleet commanded by Monf. Conflans, in that ever-glorious and memorable action off Belleifle, the 20th of November 1759, where they fatally experienced the difference of our fuperior fkill, undaunted refolution, and feamanfhip. This circumftance is certainly the greateft advantage a fleet to leeward can have, efpecially when it blows hard, with a great fea. One can hardly conceive the confufion and diforder fudden gufts of wind occafion between the men between decks, when the waves come pouring in, and lay a fhip upon her broad-fide, fo as often to endanger her overfetting, or going to the bottom before the ports can be fecured.

2. The fleet to leeward can eafier cover any of their fhips that fhould be difabled in action, which muft greatly embarrafs the fleet to windward to effect, without running the rifk of being deftroyed by the enemy in attempting it; however, thefe are difafters which both are equally fubject to.

3. The fleet to leeward may eafier make a retreat if beaten; whereas the fleet to windward cannot fo well efcape, without being reduced to the neceffity of forcing its way through the enemy's line, which muft be attended with the moft fatal confequences.

It muft be acknowledged, that a fleet which puts

A Fleet to Leeward. before the wind runs a great risk, if the enemy is in a condition to pursue it: but then there are some circumstances wherein the fleet to leeward may boldly venture to crowd away before the wind; that is to say, when night approaches, the wind freshens, the sea rises, or the enemy is embarrassed with a convoy, which may prevent their pursuing them.

Example. The allies availed themselves of these advantages, in the year 1689, off Bantry. The count de Chateau-Renaud commanded the French fleet of 24 ships of the line, and convoyed 3000 men to Ireland, with a great quantity of stores, provisions, and ammunition. My lord Herbert, who commanded a squadron of much the same force, having intelligence that the French landed their troops in Bantry-bay, resolved to go and attack them there, not doubting but he should find them in some disorder: but the count had taken his measures so prudently, and was so well prepared, that he advanced in good order to receive the English, and attacked them with so much bravery, that he soon obliged them to crowd away all the sail they could make before the wind; pursuing them till night put an end to the chace: and the count, having thus happily landed his troops, returned to Brest, where he received the just applauses due to his successful expedition; having in eleven days carried succours into Ireland, beat the enemy, took a considerable convoy, and reconducted back again his fleet to Brest in good order and condition.

IV. But to return to the explanation of the line of battle: We have already observed, that fleets in action ought to be ranged on two parallel lines; for, if formed otherwise, by inclining in the van and rear, the headmost and sternmost ships will be engaged, whilst the ships in the centre will be out of the reach of each other's guns: a consequence too obvious to need any demonstration.

The ships ought to keep at a cable's length from each other, or closer, if judged convenient or necessary: otherwise, if too far asunder, one ship of such line will be exposed to the fire of two ships at a time, from the closer and more regular line of the enemy.

The size of the ships is likewise too important a point not to be properly considered in a line of battle, as it contributes more to its strength than the number of the fleet; for two reasons. 1. A large ship carries more guns, and heavier metal: so that a fleet consisting of such ships is of greater force than a more numerous fleet of smaller ships, though drawn up in a closer line; because they engage the enemy with more, as well as heavier artillery, in the same space. 2. The great ships are stronger timbered, and consequently better able to resist the shot of the enemy; therefore of greater service in action than a fleet of smaller ships, notwithstanding the advantage of a closer line; because that each ship of the former is attacked only by a less number of guns of the latter that can do her any damage.

Plate CXCVIII. fig. 7. V. *To form a line of battle from the order of retreat.* Suppose the fleet AGF in a retreating form, to change it into a line of battle, the headmost ship A must haul up upon a wind, and the rest of the fleet, running large four points on the same tack, will form itself in her wake, or the line IH. To dispute the Wind.

This evolution is so regular, so simple, and short, that it makes this order of retreat preferable to any other; for a fleet that retreats may be often obliged to come to action: it would be then greatly embarrassed, if it could not immediately resume the line again by so easy and regular a method as this. In effect, by way of illustration, let us suppose, that the enemy LLM press the fleet so close in its pursuit, as to force it to come to an engagement; then the ships that were sailing large, haul upon a wind all together, as soon as possible, on the larboard tack, the head A hauling up at the same time. This manœuvre (method of working) can cause no confusion in the fleet: on the contrary, it then presents its sides with greater advantage to the enemy; and the ships that range themselves upon a wind in the wake of the ship A, will force between two fires the enemy's ships M.

We suppose that the enemy attack only one side; for they will find it difficult in effect to attack both, without running the risk at the same time of being separated: but admit that the enemy did attack on both sides, you may still perform the evolution equally the same; and the ships GF would present their sides to the enemy, as well as when they were sailing large or before the wind.

Chap. VI. *Some necessary Manœuvres before an Engagement.*

§ 1. *To dispute the Wind with the Enemy.*

1. The fleet to leeward should avoid extending itself the length of the enemy's line, in order to oblige them to edge down upon theirs, if they intend to attack them; which will be a means, if they still persist in doing so, of losing the advantage of the wind.

It is impossible for a fleet to leeward to gain to windward so long as the enemy keep their wind, without a change happens in their favour. Therefore all that a fleet to leeward can do, must be to wait with patience for such a happy change, which they will undoubtedly avail themselves of, as well as any mistake or inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impossible for the latter to bring them to action, without running the hazard, by bearing down, of losing the advantage of the wind, which both fleets will be so desirous of preserving.

2. In fine, that an admiral may benefit by the shifts of wind that frequently happen, he must in a manner foresee them; which will not appear so extraordinary to officers of any experience, who know what winds reign most on the coast, or off the head-lands where they may expect an enemy: and though an admiral may be sometimes out in his conjecture, he also as often succeeds so happily as to gain the advantage of his enemy.

Monf. du Quesne, the French admiral, by his superior skill in these particulars, gained a considerable advantage over the Dutch fleet, when he engaged them off Strombolo in the year 1676. He waited till the next day for a shift of wind; which happened in his favour as he foresaw, and gave him an opportuni-

ty

To avoid or force an Action.

ty of tacking to windward of the enemy, and bearing down upon them in good order: an advantage they neglected the day before; which fatal overſight they could never afterwards recover.

3. The diſpoſition or projecting of head-lands, of currents in the Mediterranean, and tides in the ocean, contribute greatly towards gaining the wind of the enemy: for ſometimes you may only range a coaſt along, or keep out in the offing, to gain a few leagues upon a tack; and we may ſay, we think with juſtice, that the knowledge of theſe advantages is as eſſential to an admiral at ſea, as the geography of the ſeveral countries, with their woods, roads, courſe of rivers, &c. he is obliged to march through, is to a general of an army on ſhore.

4. The fleet to windward ought to keep the enemy as much as poſſible always a breaſt of it; becauſe, by doing ſo, they will preſerve the advantage they may have, unleſs the wind greatly changes againſt them. They ſhould force them likewiſe to keep their wind, unleſs they think it more prudent not to engage; but when that is the caſe, they ſhould keep entirely out of ſight of the enemy.

§ 2. *To avoid an Action.*

1. The fleet to windward can never be forced to engage; becauſe it can always continue on that tack, which keeps the enemy at the greateſt diſtance from it, by ſtretching out upon one tack whilſt they continue upon the other.

If the wind was not ſo ſubject to change, it would be very eaſy for the fleet to windward to keep in ſight of the enemy, without being under any apprehenſions of being forced to come to action; but the inconſtancy of the wind obliges the moſt experienced admirals to avoid meeting the enemy, when they think it improper to engage them. The reaſon of this maxim is founded upon the impoſſibility of an inferior fleet's avoiding an action, when in preſence for any time of a ſuperior fleet.

2. If the fleet that endeavours to avoid coming to action be to leeward, they will edge away the ſame as the enemy; but, at the ſame time, they ſhould not go away right afore the wind, without making their retreat in a half-moon, if in ſight of the enemy. So that the fleet to leeward, which is not for engaging, ſeeing the enemy ſtill perſiſt in chacing them, will bear away as they do, in order to keep them at the ſame diſtance.

There are ſome circumſtances in which the fleet to leeward may put afore the wind, without ranging it into the order of a retreat; that is, when it only deſigns to prolong the engagement, or is reſolved to engage the enemy, if they ſtill continue to purſue them to bring them to action. But, except on ſuch extraordinary occaſions, the form of a retreat puts the fleet into the beſt poſture of defence, and with the leaſt hazard and danger.

§ 3. *To force the Enemy to Action.*

Axiom I. We may look upon it as a general maxim: "When two fleets of equal force remain long in ſight, they may alternately force each other to bring on an action." The following reaſons ſupport this maxim.

To double an Enemy.

If the fleet that wants to bring on an engagement is to leeward, they muſt endeavour to keep on that tack which forereaches moſt upon the enemy, that they may keep them better in view, till the wind may happen to change in their favour.

The leaſt experience at ſea will ſerve to convince us, that it is almoſt impoſſible for a fleet that once diſcovers itſelf to the enemy, ever to retire or eſcape, unleſs it ſecures itſelf in ſome port or harbour; for fleets are generally at ſea at a ſeaſon of the year when the nights are very ſhort, and the days long; ſo that any ſtratagems or falſe courſes they may uſe, will avail them but little to eſcape the purſuit of a watchful enemy: beſides, a fleet would not run the hazard of crowding too much ſail by night, for fear of being ſeparated, which may be attended with fatal conſequences. A recent example of ſuch conduct happened with Monſ. de la Clue in 1759, who, by crowding away too much ſail at night, to puſh through the gut of Gibraltar with a ſtrong eaſterly wind, before morning loſt ſight of half his fleet, and ſubjected himſelf of courſe, by ſuch imprudence, to fall much the eaſier victim to admiral Boſcawen, who was in cloſe purſuit of him with his whole ſquadron, and engaged him the next day with a ſuperior force; which obliged the French admiral to make a running fight, tho' it availed him but little, as five out of his ſquadron were burnt or taken on the coaſt of Portugal.

Axiom II. It is ſcarcely poſſible for a much inferior fleet to remain long in preſence of an enemy, without being forced to an action. 1. A fleet that is ſuperior in number may ſend a detachment of its beſt cruiſers after the flying ſquadron, and ſoon bring it to action. 2. It may divide itſelf into three ſquadrons, leaving a conſiderable interval between each; then, whatever courſe the enemy may take to eſcape, one or other will be always ready to intercept it.

The only reſource an inferior ſquadron can have in ſuch circumſtances is, to bear away in the form of a half-moon: though even then, it can have no great hopes of avoiding an engagement, if the enemy perſiſts in chacing it to bring it to action, unleſs they ſteer for ſome harbour or friendly aſylum to ſecure themſelves in.

Corollary. We may from all this draw the following concluſive inference, that it is almoſt impoſſible for an inferior fleet, under any pretext whatever, to continue long in the preſence of one greatly ſuperior to it, without being forced to action.

§ 4. *To double an Enemy.*

To facilitate this, the ſuperior fleet muſt endeavour to ſtretch out the length of the enemy's line, and at the ſame time, leaving ſhips a-ſtern, to cloſe and double upon that of the enemy's, and force them between two fires.

1. If the ſuperior fleet is to windward, it may ſo much the eaſier double its rear upon that of the enemy's, and force it between two fires; and even if it ſhould be to leeward, it ſhould likewiſe leave ſome ſhips a-ſtern of it, becauſe of the wind's often changing during the action; beſides, the fleet to leeward may inſenſibly edge away in the heat of the engagement, to give its rear an opportunity of doubling upon the enemy, by immediately luffing up cloſe to the

 wind

To avoid being doubled.

wind again.

2. There are who maintain, that the enemy's line ſhould be doubled a-head rather than a-ſtern: becauſe, ſay they, if the enemy's van is once put into diſorder, it will of courſe fall a-ſtern upon the reſt of the line, and throw it into confuſion. But, on the contrary, it ſeems plain, that the ſhips will be leſs expoſed, and find it ſafer to double upon the enemy's line a-ſtern: for if a ſhip ſhould be diſabled a-head, it does not appear how ſhe can recover her own line again; whereas if a ſhip ſhould be diſmaſted in attempting the ſame in the enemy's rear, ſhe cannot be attacked by any of their line, without expoſing themſelves at the ſame time to the fire of two ſhips; therefore may remain a-ſtern out of danger, till ſhe has repaired her damages again.

Plate CXCIX. fig. 8.

Fig. 9.

3. It ſeems equally clear, that if the ſhips E, M, of the fleet CD, had doubled the head A, they would run a great hazard of being deſtroyed: for if the ſhip E ſhould be diſabled, how can ſhe recover her own line again? how eaſy might the enemy deſtroy her? On the contrary, if the ſhips LN, of the fleet FG, have doubled the rear I of the enemy, and the ſhip L ſhould be diſabled, ſhe may remain a-ſtern, without being under any apprehenſion from the rear I, which is already hard preſſed by the ſhips G, N.

Nothing can illuſtrate this method of working a fleet better than the famous engagement off la Hogue in the year 1692, between the count de Tourville and admiral Ruſſel. The French, having the wind, bore down in good order upon the Engliſh: but, being at the ſame time ſo much inferior in number, it was impoſſible for them to extend their line the length of the enemy's; therefore could not prevent the Engliſh from extending their rear a great way a-ſtern of the French, which made their line ſo much the longer in attempting it, and conſequently the ſhips wider aſunder, (a great diſadvantage againſt a cloſe line): The wind, which was at firſt S. W. changing to the N. W. gave the rear of the Engliſh an opportunity of ſtill cloſing its line more, and doubling upon the French; ſo that the count de Tourville with his diviſion ſoon found himſelf ſurrounded by his enemies on all ſides; in which unlucky ſituation he diſtinguiſhed himſelf with the greateſt bravery and reſolution imaginable, tho' overpowered by numbers, whoſe great ſuperiority of force could be no longer reſiſted.

§ 5. *To avoid being doubled.*

To prevent any of the enemy's line from doubling upon your's, you muſt not ſuffer them to extend any of their ſhips beyond your rear; in order to which, there are ſeveral methods to be taken when your fleet is inferior in number.

Fig. 10.

1. If you are to windward, you need not extend your line the length of the enemy's van, but attack their ſecond diviſion F with your van A; by which means their firſt diviſion FG will be in a manner uſeleſs; and if they ſhould ſtretch out a-head to tack upon you, they will loſe too much time, and run the riſk of being ſeparated by the calm which generally happens in the courſe of a ſea-engagement, occaſioned by the continual diſcharge of cannon on both ſides; you may even leave a great opening in the centre E, provided you take the neceſſary precautions to prevent your van-guard from being cut off: and thus, however inferior you may be in number, you will have it in your power to interrupt the enemy's line from extending itſelf beyond, or a-ſtern of, your rear.

To avoid being doubled.

Example. Admiral Herbert's method of ranging his fleet, when he engaged the French off Beachyhead, in the year 1690, was generally approved of. He had ſome few ſhips leſs than the enemy, and was reſolved to uſe his utmoſt efforts againſt their rear; to effect which, he ordered the firſt diviſion of the Dutch to bear down upon the ſecond diviſion of the French, at the ſame time opening his fleet in the centre, leaving a great ſpace a-breaſt of the main body of the enemy. He then cloſes his rear, which he oppoſes to theirs, keeping himſelf with his diviſion at ſome diſtance a-breaſt of the centre: then cloſing his ſhips as much as poſſible, he oppoſes them to the enemy's rear, at the ſame time reſerving his own diviſion to attack the French, if they ſhould attempt to puſh through the opening in the middle, in order to double upon the Dutch. By this method (which ſhewed great forethought and experience) he rendered the enemy's firſt diviſion almoſt uſeleſs, becauſe of its being obliged to ſtretch out a long way a-head to tack upon his van: and the calm which afterwards came on had in a great meaſure deprived it of partaking of the danger and glory of the action.

2. If the inferior fleet is to leeward, you might leave a greater interval in the centre and leſs in the van; but then you ſhould have a ſmall corps de reſerve of capital ſhips and fire-ſhips, that the enemy may not take the advantage of the intervals in your fleet to cut off your line.

3. There are ſome again for giving it as a general rule, that the commanding officers of the inferior fleet ſhould oppoſe themſelves to the reſpective general officers of the enemy; by this means ſeveral of their ſhips will remain uſeleſs in the intervals, and will be rendered incapable of doubling upon you.

This method has its inconveniencies, becauſe the van and rear of each diviſion is expoſed to the fire of two ſhips at a time, and does not ſecure the laſt diviſion from the hazard of being doubled by the enemy's rear; but, to remedy this, you may place the larger ſhips in the van and rear of each diviſion, and order it ſo that the laſt diviſion may not have it in its power to extend its rear a-ſtern of yours.

4. Again, others will have it, that the three ſquadrons of the inferior fleet ſhould attack each a ſquadron of the ſuperior fleet; obſerving at the ſame time, that each ſquadron extends its line far enough to prevent the oppoſite line from leaving any ſhips a-ſtern of it, but rather a-head.

5. In fine, there are who rather chooſe, that the inferior fleet ſhould ſtretch its line ſo long, as to leave a great diſtance between the ſhips, that it may extend its line the length of the enemy's. But this ſeems to be the worſt method that can be taken; becauſe it gives the enemy's fleet all the advantage it can deſire of exerting its whole force upon the inferior line: tho' it muſt be allowed, upon certain occaſions, this method would be very proper to follow; ſuch as, when the enemy's ſhips, though more in number, are not of ſuch force and weight of metal as the ſhips of the inferior fleet.

§ 6.

Fig. 11.

Fig. 12.

Fig. 13.

A.Bell S.

To force the enemy's Line.

§ 6 *To receive a Fleet that bears down upon you.*

The fleet to leeward feeing the enemy bear down upon it, will of courfe range itfelf, as expeditioufly as poffible, into a line of battle, by edging away a little, to gain as much time as may be neceffary to form the line without confufion. They fhould not omit at the fame time leaving fome fmall intervals between the divifions, that the fleet may be the better able to diftinguifh, and have more room for action: then each commander will exert his utmoft to keep his fhip a-breaft of any fhip of the enemy's that happens to fall to his lot; either by making more or lefs fail, or even tacking, (if abfolutely neceffary), to preferve his ftation with regard to the enemy.

§ 7. *To force through the Enemy's Line.*

1. We find in the feveral relations of the wars between the Englifh and Dutch, that they had often alternately traverfed and charged through each other's fleets; that is to fay, the fleet to leeward CHD, having ftretched out a little a-head, tacked upon the enemy AB, and forced through their line at E, then re-tacking upon them immediately at C, on the other fide, gained the wind of them; but then again, the others, in their turn, regained the fame advantage of them, and cut them off from their line. Thus they mutually traverfed each other, cutting off and deftroying one another's fhip's, with an invincible obftinacy and bravery not to be defcribed.

Plate CC. fig. 11.

This manner of fighting and working a fleet is equally daring and hazardous, and requires the moft confummate ability as well as experience to fucceed in it fo happily as the count d'Etrécs did in an engagement with the Dutch in the Texel in the year 1673. He traverfed and charged through the fquadron of Zealand, gained the wind of them, and threw them into fuch diforder, that the victory, which was before doubtful, now manifeftly declared in his favour.

2. It fhould feem eafy for the fleet to windward to hinder the enemy to leeward from forcing through their line; which, whenever they attempted, the other fleet may tack at the fame time all together, and thereby effectually prevent them from fucceeding.

3. It does not therefore appear why we fhould be under any apprehenfion from a fleet that attempts to force through our line. It even feems that it fhould never be put in practice but in the following circumftances: Such as being fometimes obliged to it, to avoid a greater evil; if the enemy fhould leave a great opening in the centre, and render part of your fleet ufelefs; or if a number of fhips fhould be difabled, &c.

4. You are fometimes obliged to traverfe the enemy's line to difengage fome of your own fhips which may happen to be cut off; in that cafe, you muft boldly rifk fomething, at the fame time not forget the neceffary precautions. 1. To clofe your fhips as much as poffible. 2. To make all the fail you can, without waiting to attack the enemy as you force through their line. 3. As foon as you have got through, you fhould tack again without lofs of time, left the enemy fhould ftand on upon the fame tack with the fhips that had broke through their line.

Admiral de Ruyter put this fort of traverfes in practice to the greateft advantage, when he beat the Englifh fleet under general Monk in the year 1666, three days fucceffively, on the north of England.

Of a General Action.

Chap. VII. *Of a general Action between two Fleets.*

§ 1. *General Obfervations.*

The engagement will not begin before the admiral makes the fignal, unlefs an action is infenfibly brought on by fome unavoidable circumftances in the line or pofition of the van or rear of both fleets, in forming or approaching each other: the admiral, in fuch cafe, will make the proper fignal for the van or rear, by the diftinguifhing flag of either of thefe divifions; which will undoubtedly regulate the neceffary manœuvres of the reft of the fleet through the whole line.

The admiral in action carries but little fail: in which, however, he muft conduct himfelf by the motions of the enemy; the fhips always obferving to keep clofe in the line; and wherever they do not, the fhips which immediately follow, fhould pay no regard to thofe that precede them, if they fhould unguardedly leave too great an opening from the reft, unlefs ordered fo to do by fignal from the admiral.

The fhips ought to be particularly careful not to fire till they find themfelves nigh enough for the line to do effectual execution; otherwife it will be but expending a quantity of ammunition to very little purpofe. They ought principally to level well their guns, without that hurry or confufion too often practifed in firing broadfides; and from which fo little advantage in general is derived, to anfwer the end propofed, that of defeating the enemy, which may be much fooner accomplifhed by a more regular and fteady fire, conftantly kept up without intermiffion, the better to embarrafs their line, and divert their attention, more than broad-fide and broad-fide, with fome intervals between (as muft naturally happen), will ever effect. We ought to be convinced of this general truth, That of all actions, a fea-fight (except in the article of boarding) fhould be conducted with the leaft hurry or precipitation in order to fucceed.

A captain muft not quit his poft in the line upon any pretence whatever, unlefs his fhip fhould be fo greatly incommoded as to render her incapable of continuing the action: the little fail a fleet is under at fuch time, in general, may give the fhips, though damaged in their rigging, &c. time enough to repair their defects, without caufing an unneceffary interruption in the line, by withdrawing out of action, when their fervice might perhaps be of the utmoft importance to the reft of the fleet.

A captain, through too impetuous a defire of diftinguifhing himfelf, ought never to break the order of the line, however inviting the advantage of an attack might then appear to him to fecure fuccefs: he muft wait with patience the fignal from the admiral or commanding officer of his divifion, becaufe it is always more effential to preferve and fupport a clofe line in action, as it conftitutes the principal ftrength of a fleet in general, than to attend to a particular attack between two fhips, which commonly decides but little with regard to the whole, however glorious in appearance, unlefs with a view at the fame time of taking or deftroying a flag-fhip of the enemy's, and where fuccefs alone, even then, can juftify the attempt.

The

Of a Detachment.

The two immediate seconds to the admiral ought to direct part of their fire against the enemy's flag-ſhip, or any other that may attack their admiral; ſo that their chief attention ſhould be employed more in his defence, than in that of their own proper ſhips, as they muſt ſacrifice every other conſideration to the honour of their flag.

The ſame attention muſt likewiſe be paid to any other ſhip that may find herſelf engaged with one of the enemy's flag-ſhips; the next to her a-head and a-ſtern ſhould ſerve in that reſpect as ſeconds, by dividing part of their fire againſt ſuch flag-officer, in order to make him ſtrike the ſooner.

If any flag-officer ſtand in need of being ſuccoured, he will of courſe make a ſignal for the corps-de-reſerve; or if there ſhould be none, he will ſignify the ſame to his diviſion; on which his two ſeconds, with thoſe nigheſt him, will cloſe in to cover him, and continue on the action: the frigates of his ſquadron will likewiſe be ready to give him the neceſſary aſſiſtance; and, if he ſhould ſtill continue the attack, he will be in a particular manner ſupported by his whole diviſion.

Thoſe ſhips that happen to be moſt expoſed to danger, will naturally make the ordinary ſignals upon the occaſion, if they ſhould receive any hurt or damage, in order to be ſupported by ſuch in the line as are within reach of them.

§ 2. *To detach from the Line a Corps-de-reſerve.*

When a fleet is ſo far ſuperior in number as to be able to extend itſelf both a-head and a-ſtern conſiderably beyond the enemy's line, if then the admiral ſhould think it expedient, that ſuch ſhips as may not be a-breaſt of the enemy, ſhould detach themſelves from the line, and form to windward or to leeward into a body of reſerve; thoſe of the ſecond diviſion of the van-guard, or thoſe of the ſecond in the rear, will immediately detach themſelves from the body of the fleet, after the repetition of the ſignal from the commanding officers of their diviſions, and place themſelves in a line with the frigates nigheſt a-breaſt of the centre of the fleet, if to windward; or if to leeward, ſomewhat a-head of the ſame; being careful at the ſame time to keep within reach of obſerving diſtinctly all the ſignals and motions of the fleet, to be the readier at hand to re-place ſuch of the ſhips as may happen to be diſmaſted or drove out of the line, where all intervals muſt be properly ſtrengthened and carefully filled up again without loſs of time.

The oldeſt captain, after the ſenior officer who commands the reſerve, ought to relieve the firſt, or cloſe that part of the line where the diſabled ſhip has been obliged to quit; and ſo on ſucceſſively of the reſt.

The commanding officer of the body of reſerve will not be detached with the whole corps, unleſs on ſome preſſing occaſion to fortify the line, where ſuch reinforcement is immediately neceſſary; if to defend one of the flag-officers of the three ſquadrons, he will be followed by the next ſenior officer of the reſerve, who was not before detached, in order to place themſelves as ſeconds, the firſt a-head and the other a-ſtern of the flag they are to ſupport, without any diminution of the honour of his own proper ſeconds at the ſame time, as they are only called in thro' neceſſity on that emergency, being not engaged before, and conſequently better able to aſſiſt and ſupport the admiral; their duty being likewiſe to exert their utmoſt efforts in attacking or boarding (if poſſible) the enemy's flag-ſhip to force him to yield, except they are particularly ordered off to ſome other quarter or part of the line.

Of Boarding.

The admiral will ſometimes order the whole body of reſerve to reinforce one of the three ſquadrons of the fleet, as he may ſee occaſion; which when he does, the corps muſt make all the ſail it can, that each ſhip may place herſelf, ſucceſſively, the firſt in the firſt interval, the ſecond in the ſecond, and ſo on throughout; but if the admiral ſhould want only part of that body, he will make the ſignal accordingly.

If the admiral, commanding an equal or ſuperior number of ſhips to the enemy, ſhould judge it neceſſary to have a ſmall reſerve of one or two ſhips for each of the three ſquadrons of the fleet, the ſhips for that purpoſe in each of the three bodies are made known by ſignal for the reſerve; they will immediately draw out of the line upon hoiſting the ſame, and form themſelves on the line with the frigates, at a convenient diſtance from their commanding officer: that is to ſay, the firſt a-breaſt, and under cover of the headmoſt ſecond; and the other a-breaſt, and under cover of the admiral, to be in readineſs to run in between him and one of his ſeconds, to enable him the better to continue on the action with freſh vigour, and preſs the enemy with unremitting ardour to ſtrike as ſoon as poſſible.

The corps-de-reſerve is generally formed at the ſame time with the line, to prevent any irregularity that may happen on leaving any intervals or openings; tho' the admiral may, if he thinks proper, draw ſhips out of the line during the action, to form a body of reſerve, according to the time or circumſtances of his ſituation, &c.

When the admiral finds he has no further occaſion for his body of reſerve, he will make proper ſignals for ſuch ſhips to reſume their reſpective poſts in the line again; the corps-de-reſerve will always repeat the ſignals which regard themſelves particularly.

§ 3. *Of Boarding.*

When the admiral ſhall judge it neceſſary or convenient to prepare the fleet for action, he will make the ſignal proper for the occaſion, and the fleet will at the ſame time make the neceſſary diſpoſition for boarding. If the admiral deſign to board any of the enemy's ſhips, he will undoubtedly make the proper ſignal for the whole fleet, a particular ſquadron, or, in fine, for a particular ſhip, by the different poſition of the ſignal, and the diſtinguiſhing mark of ſuch ſquadron or diviſion, or particular pennant of ſuch ſhip.

If any captain in the fleet think he can board with ſucceſs one of the enemy's ſhips, he will ſignify the ſame to the admiral by hoiſting the boarding flag, together with his particular pendant, to be more plainly diſtinguiſhed; the admiral, in return, will make the proper ſignal of approbation, or otherwiſe, if he diſapprove the attempt, by letting fly at the ſame time that ſhip's particular pennant, that ſhe may obſerve the ſignal the better.

When a captain ſeems to expreſs an ardent deſire of diſtinguiſhing himſelf by boarding one of the enemy's ſhips, he ought to conſider well the ill conſequences that

that might perhaps attend ſuch enterpriſe, if he fail of ſucceſs; for the breaking the order or diſpoſition of the line, by quitting his poſt, may be of much greater diſadvantage to the whole, than any advantage ariſing from his victory, except that over a flag-ſhip.

§ 4. *The Fire-ſhips to prepare.*

When the admiral makes the ſignal for his fleet to prepare for action, the fire-ſhips will at the ſame time get ready their grappling-irons, fire-engines, &c. for boarding, and will likewiſe diſpoſe all their combuſtibles into their proper channels of communication, &c. as ſoon as poſſible after the action begins: all which, when ready, they will take care to make known by ſignal to the particular diviſion or ſquadron they belong to, and they of courſe will repeat the ſame to the admirals.

The fire-ſhips muſt be particularly careful in placing themſelves out of the reach of enemy's guns, which they may do a-breaſt, and under ſhelter of their own ſhips in the line, and not in the openings between the ſhips, unleſs to prevent any of the enemy's ſhips that ſhould attempt to force through their line; when they muſt, in ſuch caſe, uſe their utmoſt efforts to prevent them. They ought always to be very attentive to the admiral's ſignals, as well as thoſe of the commanding officer of the particular ſquadrons they belong to, that they may loſe no time when the ſignal is made for them to act, which they muſt quickly anſwer by a ſignal in return.

Although no ſhip in the line might be particularly appointed to lead down or protect the fire-ſhips, beſides the frigates already ordered by eſpecial appointment to attend that ſervice; yet notwithſtanding, the ſhip a-head of which the fire-ſhip paſſes in her way to the enemy is to eſcort her, whatever diviſion ſhe may belong to, and muſt aſſiſt her with a boat well-manned and armed, as well as any other ſuccour ſhe may ſtand in need of: the two next ſhips to her muſt likewiſe give her all neceſſary aſſiſtance. The captain of a fire-ſhip is to conſider, in ſhort, that he is anſwerable for the event, in proportion as he expects to be honourably rewarded, if he ſucceed in ſo daring and hazardous an enterpriſe.

§ 5. *Particular Deſcription of the Oeconomy of a naval Engagement.*

Since a general engagement of fleets or ſquadrons of men of war is nothing elſe than a variety of particular actions of ſingle ſhips with each other, in a line of battle; it may not be improper to begin by deſcribing the latter, and then proceed to repreſent the uſual manner of conducting the former.

I. The whole œconomy of a naval engagement may be arranged under the following heads, viz. the preparation, the action, and the repair, or refitting for the purpoſes of navigation.

1. The preparation is begun by iſſuing the order to clear the ſhip for action, which is repeated by the boatſwain and his mates at all the hatchways, or ſtaircaſes, leading to the different batteries. As the management of the artillery in a veſſel of war requires a conſiderable number of men, it is evident that the officers and ſailors muſt be reſtrained to a narrow ſpace in their uſual habitations, in order to preſerve the internal regularity of the ſhip. Hence the hammocs, or hanging-beds, of the latter are crowded together as cloſe as poſſible between the decks, each of them being limited to the breadth of fourteen inches. They are hung parallel to each other, in rows ſtretching from one ſide of the ſhip to the other, nearly throughout her whole length, ſo as to admit of no paſſage but by ſtooping under them. As the cannon therefore cannot be worked while the hammocs are ſuſpended in this ſituation, it becomes neceſſary to remove them as quick as poſſible. By this circumſtance a double advantage is obtained: the batteries of cannon are immediately cleared of an encumbrance, and the hammocs are converted into a ſort of parapet, to prevent the execution of ſmall-ſhot on the quarter-deck, tops, and fore-caſtle. At the ſummons of the boatſwain, *Up all hammocs!* every ſailor repairs to his own, and, having ſtowed his bedding properly, he cords it up firmly with a laſhing or line provided for that purpoſe. He then carries it to the quarter-deck, poop, or forecaſtle, or wherever it may be neceſſary. As each ſide of the quarter-deck and poop is furniſhed with a double net-work, ſupported by iron cranes fixed immediately above the gunnel or top of the ſhip's ſide, the hammocs thus corded are firmly ſtowed by the quarter-maſter between the two parts of the netting, ſo as to form an excellent barrier. The tops, waiſte, and forecaſtle, are then fenced in the ſame manner.

Whilſt theſe offices are performed below, the boatſwain and his mates are employed in ſecuring the ſail-yards, to prevent them from tumbling down when the ſhip is cannonaded, as ſhe might thereby be diſabled, and rendered incapable of attack, retreat, or purſuit. The yards are now likewiſe ſecured by ſtrong chains or ropes, additional to thoſe by which they are uſually ſuſpended. The boatſwain alſo provides the neceſſary materials to repair the rigging, wherever it may be damaged by the ſhot of the enemy, and to ſupply whatever parts of it may be entirely deſtroyed. The carpenter and his crew in the mean while prepare his ſhot-plugs and mauls, to cloſe up any dangerous breaches that may be made near the ſurface of the water; and provide the iron-work neceſſary to refit the chain-pumps, in caſe their machinery ſhould be wounded in the engagement. The gunner with his mates and quarter-gunners is buſied in examining the cannon of the different batteries, to ſee that their charges are thoroughly dry and fit for execution; to have every thing ready for furniſhing the great guns and ſmall arms with powder, as ſoon as the action begins; and to keep a ſufficient number of cartridges continually filled, to ſupply the place of thoſe expended in battle. The maſter and his mates are attentive to have the ſails properly trimmed, according to the ſituation of the ſhip; and to reduce or multiply them, as occaſion requires, with all poſſible expedition. The lieutenants viſit the different decks, to ſee that they are effectually cleared of all encumbrance, ſo that nothing may retard the execution of the artillery; and to enjoin the other officers to diligence and alertneſs, in making the neceſſary diſpoſitions for the expected engagement, ſo that every thing may be in readineſs at a moment's warning.

When the hoſtile ſhips have approached each other to a competent diſtance, the drums beat to arms. The

Oeconomy of a naval Engagement.

The boatſwain and his mates pipe, *All hands to quarters!* at every hatchway. All the perſons appointed to manage the great guns immediately repair to their reſpective ſtations. The crows, handſpikes, rammers, ſpunges, powder-horns, matches, and train tackles, are placed in order by the ſide of every cannon. The hatches are immediately laid, to prevent any one from deſerting his poſt by eſcaping into the lower apartments. The marines are drawn up in rank and file on the quarter-deck, poop, and foreeaſtle. The laſhings of the great guns are caſt looſe, and the tompions withdrawn. The whole artillery, above and below, is run out at the ports, and levelled to the point-blank range ready for firing.

2. The neceſſary preparations being completed, and the officers and crew ready at their reſpective ſtations to obey the order, the commencement of the action is determined by the mutual diſtance and ſituation of the adverſe ſhips, or by the ſignal from the commander in chief of the fleet or ſquadron. The cannon being levelled in parallel rows, projecting from the ſhip's ſide, the moſt natural order of battle is evidently to range the ſhips abreaſt of each other, eſpecially if the engagement is general. The moſt convenient diſtance is properly within the point-blank range of a muſket, ſo that all the artillery may do effectual execution.

The combat uſually begins by a vigorous cannonade, accompanied with the whole efforts of the ſwivel-guns and the ſmall arms. The method of firing in platoons, or volleys of cannon at once, appears inconvenient in the ſea-ſervice, and perhaps ſhould never be attempted unleſs in the battering of a fortification. The ſides and decks of the ſhip, although ſufficiently ſtrong for all the purpoſes of war, would be too much ſhaken by ſo violent an exploſion and recoil. The general rule obſerved on this occaſion throughout the ſhip, is to load, fire, and ſpunge, the guns with all poſſible expedition, yet without confuſion or precipitation. The captain of each gun is particularly enjoined to fire only when the piece is properly directed to its object, that the ſhot may not be fruitleſsly expended. The lieutenants, who command the different batteries, traverſe the deck to ſee that the battle is proſcuted with vivacity; and to exhort and animate the men to their duty. The midſhipmen ſecond theſe injunctions, and give the neceſſary aſſiſtance wherever it may be required, at the guns committed to their charge. The gunner ſhould be particularly attentive that all the artillery is ſufficiently ſupplied with powder, and that the cartridges are carefully conveyed along the decks in covered boxes. The havoc produced by a continuation of this mutual aſſault may be readily conjectured by the reader's imagination: battering, penetrating, and ſplintering the ſides and decks; ſhattering or diſmounting the cannon; mangling and deſtroying the rigging; cutting aſunder or carrying away the maſts and yards; piercing and tearing the ſails ſo as to render them uſeleſs; and wounding, diſabling, or killing the ſhip's company! The comparative vigour and reſolution of the aſſailants to effect theſe pernicious conſequences in each other, generally determine their ſucceſs or defeat: we ſay generally, becauſe the fate of the combat may ſometimes be decided by an unforeſeen incident, equally fortunate for the one and fatal to the other. The defeated ſhip having acknowledged the victory, by ſtriking her colours, is immediately taken poſſeſſion of by the conqueror, who ſecures her officers and crew as priſoners in his own ſhip; and inveſts his principal officer with the command of the prize until a captain is appointed by the commander in chief.

3. The engagement being concluded, they begin to repair: the cannon are ſecured by their breechings and tackles, with all convenient expedition. Whatever ſails have been rendered unſerviceable are unbent; and the wounded maſts and yards ſtruck upon deck, and fiſhed, or replaced by others. The ſtanding rigging is knotted, and the running-rigging ſpliced wherever neceſſary. Proper ſails are bent in the room of thoſe which have been diſplaced as uſeleſs. The carpenter and his crew are employed in repairing the breaches made in the ſhip's hull, by ſhot-plugs, pieces of plank, and ſheet-lead. The gunner and his aſſiſtants are buſied in repleniſhing the alloted number of charged cartridges, to ſupply the place of thoſe which have been expended, and in refitting whatever furniture of the cannon may have been damaged by the late action.

Such is the uſual proceſs and conſequences of an engagement between two ſhips of war, which may be conſidered as an epitome of a general battle between fleets or ſquadrons. The latter, however, involves a greater variety of incidents, and neceſſarily requires more comprehenſive ſkill and judgment in the commanding officer.

II. When the admiral, or commander in chief, of a naval armament has diſcovered an enemy's fleet, his principal concern is uſually to approach it, and endeavour to come to action as ſoon as poſſible. Every inferior conſideration muſt be ſacrificed to this important object; and every rule of action ſhould tend to haſten and prepare for ſo material an event. The ſtate of the wind, and the ſituation of his adverſary, will in ſome meaſure dictate the conduct neceſſary to be purſued with regard to the diſpoſition of his ſhips on this occaſion. To facilitate the execution of the admiral's orders, the whole fleet is ranged into three ſquadrons, each of which is claſſed into three diviſions, under the command of different officers. Before the action begins, the adverſe fleets are drawn up in two lines, as above deſcribed. As ſoon as the admiral diſplays the ſignal for the line of battle, the ſeveral diviſions ſeparate from the columns, in which they were diſpoſed in the uſual order of ſailing, and every ſhip crowds into its ſtation in the wake of the next a-head; and a proper diſtance from each other, which is generally about 50 fathom, is regularly obſerved from the van to the rear. The admiral, however, will occaſionally contract or extend his line, ſo as to conform to the length of that of his adverſary, whoſe neglect or inferior ſkill on this occaſion he will naturally convert to his own advantage, as well as to prevent his own line from being doubled, a circumſtance which might throw his van and rear into confuſion.

When the adverſe fleets approach each other, the courſes are commonly hauled up in the brails, and the top-gallant ſails and ſtay-ſails furled. The movement of each ſhip is chiefly regulated by the main and fore-top ſails, and the jib; the mizen-top ſail being reſerved

Oeconomy of a naval Engagement.

ved to haften or retard the courfe of the fhip, and, in fine, by filling or backing, hoifting or lowering it, to determine her velocity.

The frigates, tenders, and fire-fhips, being alfo hauled upon a wind, lie at fome diftance, ready to execute the admiral's orders or thofe of his feconds, leaving the line of battle between them and the enemy. If there are any tranfports and ftorefhips attendant on the fleet, thefe are difpofed ftill further diftant from the action. If the fleet is fuperior in number to that of the enemy, the admiral ufually felects a body of referve from the different fquadrons, which will always be of ufe to cover the fire-fhips, bomb-veffels, &c. and may fall into the line in any cafe of neceffity: thefe alfo are ftationed at a convenient diftance from the line, and fhould evidently be oppofite to the weakeft parts thereof.

And here it may not be improper to obferve, with an ingenious French author (M. de Morogues), that order and difcipline give additional ftrength and activity to a fleet. If thus a double advantage is acquired by every fleet, it is certainly more favourable to the inferior, which may thereby change its difpofition with greater facility and difpatch than one more numerous, yet without being feparated. When courage is equal to both, good order is then the only refource of the fmaller number. Hence we may infer, that a fmaller fquadron of men of war, whofe officers are perfectly difciplined in working their fhips, may, by its fuperior dexterity, vanquifh a more powerful one, even at the commencement of the fight; becaufe the latter, being lefs expert in the order of battle, will, by its feparation, fuffer many of the fhips to remain ufelefs, or not fufficiently near, to protect each other.

The fignal for a general engagement is ufually difplayed when the oppofite fleets are fufficiently within the range of point-blank fhot, fo that they may level the artillery with certainty of execution, which is near enough for a line of battle. The action is begun and carried on throughout the fleet in the manner we have already defcribed between fingle fhips; at which time the admiral carries little fail, obferving, however, to regulate his own motions by thofe of the enemy. The fhips of the line meanwhile keep clofe in their ftations, none of which fhould hefitate to advance in their order, although interrupted by the fituation of fome fhip a-head, which has negligently fallen a-ftern of her ftation.

The various exigencies of the combat call forth the fkill and refources of the admiral, to keep his line as complete as poffible when it has been unequally attacked; by ordering fhips from thofe in referve to fupply the place of others which have fuffered greatly by the action; by directing his firefhips at a convenient time to fall aboard the enemy; by detaching fhips from one part of the line or wing which is ftronger, to another which is greatly preffed by fuperior force, and requires affiftance. His vigilance is ever neceffary to review the fituation of the enemy from van to rear; every motion of whom he fhould, if poffible, anticipate and fruftrate. He fhould feize the favourable moments of occafion, which are rapid in their progrefs, and never return. Far from being difconcerted by any unforefeen incident, he fhould endeavour, if poffible, to make it fubfervient to his defign. His experience and reflection will naturally furnifh him with every method of intelligence to difcover the ftate of his different fquadrons and divifions. Signals of inquiry and anfwers, of requeft and affent, of command and obedience, will be difplayed and repeated on this occafion. Tenders and boats will alfo continually be detached between the admiral and the commanders of the feveral fquadrons or divifions.

Retreat and Chace.

As the danger preffes on him, he ought to be fortified by refolution and prefence of mind; becaufe the whole fleet is committed to his charge, and the conduct of his officers may, in a great degree, be influenced by his intrepidity and perfeverance. In fhort, his renown or infamy may depend on the fate of the day.

If he conquers in battle, he ought to profecute his victory as much as poffible, by feizing, burning, or deftroying the enemy's fhips. If he is defeated, he fhould endeavour, by every refource his experience can fuggeft, to fave as many of his fleet as poffible, by employing his tenders, &c. to take out the wounded and put frefh men in their places; by towing the difabled fhips to a competent diftance; and by preventing the execution of the enemy's fire-fhips.

By what we have obferved, the real force or fuperiority of a fleet confifts lefs in the number of veffels, and the vivacity of the action, than in good order, dexterity in working the fhips, prefence of mind, and fkilful conduct in the captains.

Chap. VIII. *Of Retreat and Chace.*

I. When a fleet is obliged to retreat in fight of an enemy, the beft way to effect it fecurely will be by failing in a kind of half-moon, the admiral making the obtufe angle A, and to windward in the form BAC; one part of his fleet to fail on the ftarboard, whilft the other goes away on the larboard tack: keeping the fire-fhips, tranfports, &c. in the middle. Plate CC. fig. 12.

This manner of ranging a fleet feems the moft advifeable, becaufe the enemy can never approach thofe that endeavour to efcape, without expofing themfelves at the fame time to the fire of the fhips to windward: thus the enemy's fhips D can never approach the fhips E without expofing themfelves at the fame time to the fire of the admiral A, as likewife to that of his feconds. If the admiral thinks this form gives too great an extent to his fleet, he may eafily clofe his wings or quarters, and make the half-moon more complete; in the midft of which he may place his convoy in fafety. Fig. 13.

Example. This order of retreat was exactly followed by the Dutch admiral Van Tromp, in his engagement with the Englifh off Portland, in the year 1653. The Englifh fleet confifted of 70 fail, under the command of admiral Blake; and the Dutch were as ftrong, convoying about 200 rich merchant-fhips. The two fleets met off Portland, where the Englifh ufed their utmoft efforts to bring on an action. The Dutch had the advantage of the wind, and endeavoured to avoid an engagement to preferve their convoy; but Van Tromp, confidering rightly, that if the wind fhould happen to change, he muft be under the neceffity of fighting with lefs advantage, determined upon bearing down to the enemy, making his fignal at

Retreat and Chace.

at the fame time for the convoy to keep to windward: he then divided his fleet into three fquadrons, and attacked the enemy with great bravery: they received him with equal refolution; which made the action very defperate on both fides, feveral fhips being difabled, funk, burnt, or deftroyed; and nothing but the darknefs of the approaching night could feparate two fuch obftinate enemies: during which, each prepared to renew the action, that ftill remained undecided, with greater fury the next day. Van Tromp found himfelf much embarraffed how to act; but, after many deliberations, he refolved at laft upon that of a retreat: he therefore drew up his fleet into an half-moon, placing his convoy in the middle; that is to fay, his own fhip to windward formed the obtufe angle of the half-moon, the reft ranging themfelves on two lines upon a wind on the fame tack, in order to form the faces of the half-moon to cover their convoy. He then made what fail he could, and went away large, firing to the right and left of him at all thofe that attempted to infult his wings or quarters; and would have entirely faved his convoy, if fome of his fhips had not bafely deferted him. The Englifh fhips immediately took the advantage of the intervals thefe fhips left in the face of their floating half-moon, and carried off feveral of their merchant-fhips; which obliged admiral Tromp to replace himfelf in the line of battle as before, and continue the engagement till night fhould give him an opportunity of refuming his order of retreat. He was chaced the next day by the enemy; but, after fuftaining a few broadfides, he got fafe into harbour, having acquired by his great valour and fkill a rich convoy to his country, that narrowly efcaped falling a prey to the enemy.

The moft natural courfe in this form of failing is to fteer away before the wind: but, if neceffary, the fhips may bear away large upon either tack, or even may keep clofe upon a wind.

In flying, or retreating, the uncertainty of the weather is to be confidered: it may become calm, or the wind may fhift favourably. The admiral's fchemes may be affifted by the approach of night, or the proximity of the land; fince he ought rather to run the fhips afhore, if practicable, than fuffer them to be taken afloat, and thereby transfer additional ftrength to the enemy. In fhort, nothing fhould be neglected that may contribute to the prefervation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

II. When you chace a fleet that endeavours to efcape, you detach your beft cruifers after them, in order to pick up the ftragglers, or force them to action; the body of the victorious fleet fhould keep the fame order or line with the enemy, as nigh as poffible, to be ready for action, if neceffary. This is only to be underftood when the fleet that is chaced may not be fo inferior to the other but that it may hazard an action; for if the one bears no proportion to the other, they muft bear down upon them in the fame manner as a conquering army afhore carries all before it when it has forced an enemy's camp: otherwife, were the conquerors to wait to draw up in form, the enemy would undoubtedly take the advantage of fuch an opportunity to make their efcape.

Navarre, Naude.

NAVARRE, a province of Spain, part of the ancient kingdom of Navarre, erected foon after the invafion of the Moors; and is otherwife called *Upper Navarre*, to diftinguifh it from Lower Navarre, belonging to the French. It is bounded on the fouth and eaft by Arragon, on the north by the Pyrenees, and on the weft by Old Caftile and Bifcay; extending from fouth to north about 80 miles, and from eaft to weft about 75. It abounds in fheep and cattle; game of all kinds, as boars, ftags, and roebucks; and in wild-fowl, horfes, and honey; yielding alfo fome grain, wine, oil, and a variety of minerals, medicinal waters, and hot baths. Some of the ancient chiefs of this country were called *Sobrarbores*, from the cuftom, as it is fuppofed, which prevailed among fome of thofe free nations of choofing and fwearing their princes under fome particular tree. The name of the province is fuppofed to be a contraction of *Nava Errea*, fignifying, in the language of the Vafcones, its ancient inhabitants, "a land of valleys." —For the particulars of its hiftory, fee the article SPAIN.

NAUDE (Gabriel), a critic and phyfician in the 17th century, was born at Paris; and became librarian to the cardinals Bagni and Antonio Barberini at Rome, and afterwards to cardinal Mazarin, who made him canon of Verdun and prior of Lartige in Limofin. Chriftina queen of Sweden at length invited him into her dominions, and beftowed many marks of her favour and efteem upon him. He returned from thence, and died at Abbeville in 1653. His principal works are, 1. *Syntagma de ftudio liberali*. 2. *Syntagma de ftudio militari*. 3. An apology for the great men who have been accufed of magic. 4. Inftructions concerning the chimerical fociety of the Roficrufians. 5. Advice on collecting a library. 6. An appendix to the life of Lewis XI. 7. The fcience of princes, or political confiderations on the body of a ftate, &c. Naude's works abound with many curious and interefting particulars.

Nave ‖ Navew.

NAVE, in architecture, the body of a church, where the people are difpofed, reaching from the ballufter, or rail of the door, to the chief choir. Some derive the word from the Greek ναὸς, "a temple;" and others from ναυς, "a fhip," by reafon the vault or roof of a church bears fome refemblance to a fhip.

NAVEL, in anatomy, the centre of the lower part of the abdomen; being that part where the umbilical veffels paffed out of the placenta of the mother. See ANATOMY, p. 366. note (G).

NAVEL-*Wort*, in botany. See COTYLEDON.

NAVEW, in botany. See BRASSICA.

N A V I G A T I O N.

NAVIGATION, is the art of conducting or carrying a ſhip from one port to another.

H I S T O R Y.

THE poets refer the invention of the art of navigation to Neptune, ſome to Bacchus, others to Hercules, others to Jaſon, and others to Janus, who is ſaid to have made the firſt ſhip. Hiſtorians aſcribe it to the Æginetes, the Phœnicians, Tyrians, and the ancient inhabitants of Britain. Some will have it, the firſt hint was taken from the flight of the kite; others, as Oppian, (*De piſcibus*, lib. i.) from the fiſh called *nautilus:* others aſcribe it to accident.—Scripture refers the origin of ſo uſeful an invention to God himſelf, who gave the firſt ſpecimen thereof in the ark built by Noah under his direction. For the raillery the good man underwent on account of his enterpriſe ſhews evidently enough the world was then ignorant of any thing like navigation, and that they even thought it impoſſible.

However, hiſtory repreſents the Phœnicians, eſpecially thoſe of their capital Tyre, as the firſt navigators; being urged to ſeek a foreign commerce by the narrowneſs and poverty of a ſlip of ground they poſſeſſed along the coaſts; as well as by the conveniency of two or three good ports, and by their natural genius to traffic. Accordingly, Lebanon, and the other neighbouring mountains, furniſhing them with excelcellent wood for ſhip-building, in a ſhort time they were maſters of a numerous fleet, which conſtantly hazarding new navigations, and ſettling new trades, they ſoon arrived at an incredible pitch of opulency and populouſneſs: inſomuch as to be in a condition to ſend out colonies, the principal of which was that of Carthage; which, keeping up their Phœnician ſpirit of commerce, in time not only equalled Tyre itſelf, but vaſtly ſurpaſſed it; ſending its merchant-fleets through Hercules's pillars, now the ſtraits of Gibraltar, along the weſtern coaſts of Africa and Europe; and even, if we believe ſome authors, to America itſelf.

Tyre, whoſe immenſe riches and power are repreſented in ſuch lofty terms both in ſacred and profane authors, being deſtroyed by Alexander the Great, its navigation and commerce were transferred by the conqueror to Alexandria, a new city, admirably ſituated for thoſe purpoſes; propoſed for the capital of the empire of Aſia, which Alexander then meditated. And thus aroſe the navigation of the Egyptians; which was afterwards ſo cultivated by the Ptolemies, that Tyre and Carthage were quite forgot.

Egypt being reduced into a Roman province after the battle of Actium, its trade and navigation fell into the hands of Auguſtus; in whoſe time Alexandria was only inferior to Rome: and the magazines of the capital of the world, were wholly ſupplied with merchandizes from the capital of Egypt.

At length, Alexandria itſelf underwent the fate of Tyre and Carthage; being ſurpriſed by the Saracens, who, in ſpite of the emperor Heraclius, overſpread the northern coaſts of Africa, &c. whence the merchants being driven, Alexandria has ever ſince been in a languiſhing ſtate, though ſtill it has a conſiderable part of the commerce of the Chriſtian merchants trading to the Levant.

The fall of Rome and its empire drew along with it not only that of learning and the polite arts, but that of navigation; the barbarians, into whoſe hands it fell, contenting themſelves with the ſpoils of the induſtry of their predeceſſors.

But no ſooner were the more brave among thoſe nations well ſettled in their new provinces; ſome in Gaul, as the Franks; others in Spain, as the Goths; and others in Italy, as the Lombards; but they began to learn the advantages of navigation and commerce, and the methods of managing them, from the people they ſubdued; and this with ſo much ſucceſs, that in a little time ſome of them became able to give new leſſons, and ſet on foot new inſtitutions for its advantage. Thus it is to the Lombards we uſually aſcribe the invention and uſe of banks, book-keeping, exchanges, rechanges, &c.

It does not appear which of the European people, after the ſettlement of their new maſters, firſt betook themſelves to navigation and commerce.—Some think it began with the French; though the Italians ſeem to have the juſteſt title to it, and are accordingly ordinarily looked on as the reſtorers hereof, as well as of the polite arts, which had been baniſhed together from the time the empire was torn aſunder. It is the people of Italy then, and particularly thoſe of Venice and Genoa, who have the glory of this reſtoration; and it is to their advantageous ſituation for navigation they in great meaſure owe their glory. In the bottom of the Adriatic were a great number of marſhy iſlands, only ſeparated by narrow channels, but thoſe well ſcreened, and almoſt inacceſſible, the reſidence of ſome fiſhermen, who here ſupported themſelves by a little trade of fiſh and ſalt, which they found in ſome of theſe iſlands. Thither the Veneti, a people inhabiting that part of Italy along the coaſts of the gulph, retired, when Alaric king of the Goths, and afterwards Attila king of the Huns, ravaged Italy.

Theſe new iſlanders, little imagining that this was to be their fixed reſidence, did not think of compoſing any body politic; but each of the 72 iſlands of this little Archipelago continued a long time under its ſeveral maſters, and each made a diſtinct commonwealth. When their commerce was become conſiderable enough to give jealouſy to their neighbours, they began to think of uniting into a body. And it was this union, firſt begun in the ſixth century, but not completed till the eighth, that laid the ſure foundation of the future grandeur of the ſtate of Venice. From the time of this union, their fleets of merchantmen were ſent to all the parts of the Mediterranean; and at laſt to thoſe of Egypt, particularly Cairo, a new city, built by the Saracen princes on the eaſtern banks of the Nile, where they traded for their ſpices and other products of the Indies. Thus they flouriſhed, increaſed their commerce

commerce, their navigation, and their conquests on the terra firma, till the league of Cambray in 1508, when a number of jealous princes conspired to their ruin; which was the more easily effected by the diminution of their East-India commerce, of which the Portuguese had got one part, and the French another. Genoa, which had applied itself to navigation at the same time with Venice, and that with equal success, was a long time its dangerous rival, disputed with it the empire of the sea, and shared with it the trade of Egypt and other parts both of the east and west.

Jealousy soon began to break out; and the two republics coming to blows, there was almost continual war for three centuries ere the superiority was ascertained; when, towards the end of the 14th century, the battle of Chioza ended the strife: the Genoese, who till then had usually the advantage, having now lost all; and the Venetians, almost become desperate, at one happy blow, beyond all expectation, secured to themselves the empire of the sea, and superiority in commerce.

About the same time that navigation was retrieved in the southern parts of Europe, a new society of merchants was formed in the north, which not only carried commerce to the greatest perfection it was capable of till the discovery of the East and West Indies, but also formed a new scheme of laws for the regulation thereof, which still obtain under the names of *Uses and Customs of the Sea.* This society is that famous league of the Hanse-towns, commonly supposed to have begun about the year 1164. See HANSE *Towns.*

For the modern state of navigation in England, Holland, France, Spain, Portugal, &c. See COMMERCE, COMPANY, &c.

We shall only add, that, in examining the reasons of commerce's passing successively from the Venetians, Genoese, and Hanse-towns, to the Portuguese and Spaniards, and from these again to the English and Dutch; it may be established as a maxim, that the relation between commerce and navigation, or, if we may be allowed to say it, their union is so intimate, that the fall of the one inevitably draws after it the other; and that they will always either flourish or dwindle together. Hence so many laws, ordinances, statutes, &c. for its regulation; and hence particularly that celebrated act of navigation, which an eminent foreign author calls the *palladium* or *tutelar deity of the commerce of England;* which is the standing rule, not only of the British among themselves, but also of other nations with whom they traffic.

The art of navigation hath been exceedingly improved in modern times, both with regard to the form of the vessels themselves, and with regard to the methods of working them. The use of rowers is now entirely superseded by the improvements made in the formation of the sails, rigging, &c. by which means the ships can not only sail much faster than formerly, but can tack in any direction with the greatest facility. It is also very probable that the ancients were neither so well skilled in finding the latitudes, nor in steering their vessels in places of difficult navigation, as the moderns. But the greatest advantage which the moderns have over the ancients is from the mariner's compass, by which they are enabled to find their way with as great facility in the midst of an immeasurable ocean, as the ancients could have done by creeping along the coast, and never going out of sight of land. Some people indeed contend, that this is no new invention, but that the ancients were acquainted with it. They say, that it was impossible for Solomon to have sent ships to Ophir, Tarshish, and Parvaim, which last they will have to be *Peru,* without this useful instrument. They insist, that is was impossible for the ancients to be acquainted with the attractive virtue of the magnet, and to be ignorant of its polarity. Nay, they affirm, that this property of the magnet is plainly mentioned in the book of Job, where the loadstone is mentioned by the mane of *topaz,* or *the stone that turns itself.* But it is certain, that the Romans, who conquered Judæa, were ignorant of this instrument; and it is very improbable, that such an useful invention, if once it had been commonly known to any nation, would have been forgot, or perfectly concealed from such a prudent people as the Romans, who were so much interested in the discovery of it.

Among those who do agree that the mariner's compass is a modern invention, it hath been much disputed who was the inventor. Some give the honour of it to Flavio Gioia of Amalfi in Campania *, who lived about the beginning of the 14th century; while others say that it came from the east, and was earlier known in Europe. But, at whatever time it was invented, it is certain, that the mariner's compass was not commonly used in navigation before the year 1420. In that year the science was considerably improved under the auspices of Henry duke of Visco, brother to the king of Portugal. In the year 1485, Roderic and Joseph, physicians to king John II. of Portugal, together with one Martin de Bohemia, a Portuguese native of the island of Fayal, and scholar to Regiomontanus, calculated tables of the sun's declination for the use of sailors, and recommended the astrolabe for taking observations at sea. Of the instructions of Martin, the celebrated Christopher Columbus is said to have availed himself, and to have improved the Spaniards in the knowledge of the art; for the farther progress of which a lecture was afterwards founded at Seville by the emperor Charles V.

* See *Mariner's Compass.*

The discovery of the variation is claimed by Columbus, and by Sebastian Cabot. The former certainly did observe this variation without having heard of it from any other person, on the 14th of September 1492, and it is very probable that Cabot might do the same. At that time it was found that there was no variation at the Azores, where some geographers have thought proper to place the first meridian; though it hath since been observed that the variation alters in time.—The use of the cross-staff now began to be introduced among sailors. This ancient instrument is described by John Werner of Nuremberg, in his annotations on the first book of Ptolemy's Geography, printed in 1514. He recommends it for observing the distance between the moon and some star, in order thence to determine the longitude.

At this time the art of navigation was very imperfect on account of the inaccuracies of the plane chart, which

which was the only one then known, and which, by its grofs errors, muft have greatly mifled the mariner, efpecially in voyages far diftant from the equator. Its precepts were probably at firft only fet down on the fea-charts, as is the cuftom at this day: but at length there were two Spanifh treatifes publifhed in 1545; one by Pedro de Medina; the other by Martin Cortis, which contained a complete fyftem of the art, as far as it was then known. Thefe feem to have been the oldeft writers who fully handled the art; for Medina, in his dedication to Philip prince of Spain, laments that multitudes of fhips daily perifhed at fea, becaufe there were neither teachers of the art, nor books by which it might be learned; and Cortes, in his dedication, boafts to the emperor, that he was the firft who had reduced navigation into a compendium, valuing himfelf much on what he had performed. Medina defended the plane chart; but he was oppofed by Cortes, who fhewed its errors, and endeavoured to account for the variation of the compafs, by fuppofing the needle to be influenced by a magnetic pole (which he called the *point attractive)* different from that of the world: which notion hath been farther profecuted by others. Medina's book was foon tranflated into Italian, French, and Flemifh, and ferved for a long time as a guide to foreign navigators. However Cortes was the favourite author of the Englifh nation, and was tranflated in 1561; while Medina's work was entirely neglected, though tranflated alfo within a fhort time of the other. At that time the fyftem of navigation confifted of the following particulars, and others fimilar: An account of the Ptolemaic hypothefis, and the circles of the fphere; of the roundnefs of the earth, the longitudes, latitudes, climates, &c. and eclipfes of the luminaries; a kalendar; the method of finding the prime, epact, moon's age, and tides; a defcription of the compafs, an account of its variation, for the difcovering of which Cortes faid an inftrument might eafily be contrived; tables of the fun's declination for four years, in order to find the latitude from his meridian altitude; directions to find the fame by certain ftars: of the courfe of the fun and moon; the length of the days; of time and its divifions; the method of finding the hour of the day and night; and laftly, a defcription of the fea-chart, on which to difcover where the fhip is, they made ufe of a fmall table, that fhewed, upon an alteration of one degree of the latitude, how many leagues were run in each rhumb, together with the departure from the meridian. Befides, fome inftruments were defcribed, efpecially by Cortes; fuch as one to find the place and declination of the fun, with the days, and place of the moon; certain dials, the aftrolabe, and crofs-ftaff; with a complex machine to difcover the hour and latitude at once.

About the fame time were made propofals for finding the longitude by obfervations on the moon. In 1530, Gemma Frifius advifed the keeping of the time by means of fmall clocks or watches, then, as he fays, newly invented. He alfo contrived a new fort of crofs-ftaff and an inftrument called the *nautical quadrant;* which laft was much praifed by William Cuningham, in his *Aftronomical Glafs*, printed in the year 1559.

In 1537 Pedro Nunez, or Nonius, publifhed a book in the Portuguefe language, to explain a difficulty in navigation propofed to him by the commander Don Martin Alphonfo de Sufa. In this he expofes the errors of the plane chart, and likewife gives the folution of feveral curious aftronomical problems; amongft which is that of determining the latitude from two obfervations of the fun's altitude and intermediate azimuth being given. He obferved, that though the rhumbs are fpiral lines, yet the direct courfe of a fhip will always be in the arch of a great circle, whereby the angle with the meridians will continually change: all that the fteerfman can here do for the preferving of the original rhumb, is to correct thefe deviations as foon as they appear fenfible. But thus the fhip will in reality defcribe a courfe without the rhumb-line intended; and therefore his calculations for affigning the latitude, where any rhumb-line croffes the feveral meridians, will be in fome meafure erroneous. He invented a method of dividing a quadrant by means of concentric circles, which, after being much improved by Dr Halley, is ufed at prefent, and is called a *nonius*.

In 1577, Mr William Bourne publifhed a treatife, in which, by confidering the irregularities in the moon's motion, he fhews the errors of the failors in finding her age by the epact, and alfo in determining the hour from obferving on what point of the compafs the fun and moon appeared. He advifes, in failing towards the high latitudes, to keep the reckoning by the globe, as there the plane chart is moft erroneous. He defpairs of our ever being able to find the longitude, unlefs the variation of the compafs fhould be occafioned by fome fuch attractive point, as Cortes had imagined; of which, however, he doubts: but as he had fhewn how to find the variation at all times, he advifes to keep an account of the obfervations, as ufeful for finding the place of the fhip; which advice was profecuted at large by Simon Stevin in a treatife publifhed at Leyden in 1599; the fubject of which was the fame year printed at London in Englifh by Mr Edward Wright, intitled the *Haven-finding Art*. In this ancient tract alfo is defcribed the way by which our failors eftimate the rate of a fhip in her courfe, by an inftrument called the *log*. This was fo named from the piece of wood or log that floats in the water while the time is reckoned during which the line that is faftened to it is veering out. The author of this contrivance is not known; neither was it taken notice of till 1607, in an Eaft-India voyage publifhed by Purchas: but from this time it became famous, and was much taken notice of by almoft all writers on navigation in every country; and it ftill continues to be ufed as at firft, though many attempts have been made to improve it, and contrivances propofed to fupply its place; many of which have fucceeded in quiet water, but proved ufelefs in a ftormy fea.

In 1581 Michael Coignet, a native of Antwerp, publifhed a treatife in which he animadverted on Medina. In this he fhewed, that as the rhumbs are fpirals, making endlefs revolutions about the poles, numerous errors muft arife from their being reprefented by ftraight lines on the fea-charts; but though he hoped to find a remedy for thefe errors, he was of opinion that the propofals of Nonius were fcarcely practicable, and therefore in a great meafure ufelefs. In treating

treating of the sun's declination, he took notice of the gradual decrease in the obliquity of the ecliptic; he also described the cross-staff with three transverse pieces, as it is at present made, and which he owned to have been then in common use among the sailors. He likewise gave some instruments of his own invention; but all of them are now laid aside, excepting perhaps his nocturnal. He constructed a sea-table to be used by such as sailed beyond the 60th degree of latitude; and at the end of the book is delivered a method of sailing on a parallel of latitude by means of a ring dial and a 24 hour-glass. The same year the discovery of the dipping needle was made by Mr Robert Forman*. In his publication on that art he maintains, in opposition to Cortes, that the variation of the compass was caused by some point on the surface of the earth, and not in the heavens: he also made considerable improvements in the construction of compasses themselves; shewing especially the danger of not fixing, on account of the variation, the wire directly under the *flower-de-luce;* as compasses made in different countries have placed it differently. To this performance of Forman's is always prefixed a discourse on the variation of the magnetical needle, by Mr William Burrough, in which he shews how to determine the variation in many different ways. He also points out many errors in the practice of navigation at that time, and speaks in very severe terms concerning those who had published upon it. All this time the Spaniards had continued to publish treatises on the art. In 1585 an excellent compendium was published by Roderico Zamorano; which contributed greatly towards the improvement of the art, particularly in the sea-charts. Globes of an improved kind, and of a much larger size than those formerly used, were now constructed, and many improvements were made in other instruments; however, the plane chart continued still to be followed, though its errors were frequently complained of. Methods of removing these errors had indeed been sought after; and Gerard Mercator seems to have been the first who found the true method of doing this so as to answer the purposes of seamen. His method was to represent the parallels both of latitude and longitude by parallel straight lines, but gradually to augment the former as they approached the pole. Thus the rhumbs, which otherwise ought to have been curves, were now also extended into straight lines; and thus a straight line drawn between any two places marked upon the chart would make an angle with the meridians, expressing the rhumb leading from the one to the other. But though, in 1569, Mercator published an universal map constructed in this manner, it doth not appear that he was acquainted with the principles on which this proceeded; and it is now generally believed, that the true principles on which the construction of what is called *Mercator's chart* depends, were first discovered by an Englishman, Mr Edward Wright.

* See *Dipping-needle.*

Mr Wright supposes, but, according to the general opinion, without sufficient grounds, that this enlargement of the degrees of latitude was known and mentioned by Ptolemy, and that the same thing had also been spoken of by Cortes. The expressions of Ptolemy alluded to, relate indeed to the proportion between the distances of the parallels and meridians; but instead of proposing any gradual enlargement of the parallels of latitude, in a general chart, he speaks only of particular maps; and advises not to confine a system of such maps to one and the same scale, but to plan them out by a different measure, as occasion might require: only with this precaution, that the degrees of longitude in each should bear some proportion to those of latitude; and this proportion is to be deduced from that which the magnitude of the respective parallels bear to a great circle of the sphere. He adds, that in particular maps, if this proportion be observed with regard to the middle parallel, the inconvenience will not be great tho' the meridians should be straight parallels to each other. Here he is said only to mean, that the maps should in some measure represent the figures of the countries for which they are drawn. In this sense Mercator, who drew maps for Ptolemy's tables, understood him: thinking it, however, an improvement not to regulate the meridians by one parallel, but by two; one distant from the northern, the other from the southern extremity of the map by a fourth part of the whole depth; by which means, in his maps, though the meridians are straight lines, yet they are generally drawn inclining to each other towards the poles. With regard to Cortes, he speaks only of the number of degrees of latitude, and not of the extent of them; nay, he gives express directions that they should all be laid down by equal measurement on a scale of leagues adapted to the map.

For some time after the appearance of Mercator's map, it was not rightly understood, and it was even thought to be entirely useless, if not detrimental. However, about the year 1592, its utility began to be perceived; and seven years after, Mr Wright printed his famous treatise entitled, *The Correction of certain Errors in Navigation;* where he fully explained the reason of extending the length of the parallels of latitude, and the uses of it to navigators. In 1610, a second edition of Mr Wright's book was published with improvements. An excellent method was proposed of determining the magnitude of the earth; at the same time it was judiciously proposed to make our common measures in some proportion to a degree on its surface, that they might not depend on the uncertain length of a barley-corn. Some of his other improvements were, "The table of latitudes for dividing the meridian computed to minutes;" whereas it had only been divided to every tenth minute. He also published a description of an instrument which he calls the *sea-rings;* and by which the variation of the compass, altitude of the sun, and time of the day, may be determined readily at once in any place, provided the latitude is known. He shewed also how to correct the errors arising from the excentricity of the eye in observing by the cross-staff. He made a total amendment in the tables of the declinations and places of the sun and stars from his own observations made with a six-foot quadrant in the years 1594, 95, 96, and 97. A sea-quadrant to take altitudes by a forward or backward observation; and likewise with a contrivance for the ready finding the latitude by the height of the pole-star, when not upon the meridian. To this edition was subjoined a translation of Zemorano's Compendium above-mentioned; in which he corrected some mistakes in the original; adding a large table of the variation of the compass observed in very different parts

parts of the world, to ſhew that it was not occaſioned by any magnetical pole.

Theſe improvements ſoon became known abroad. In 1608, a treatiſe intitled, *Hypomnemata Mathematica*, were publiſhed by Simon Stevin, for the uſe of Prince Maurice. In that part relating to navigation, the author having treated of ſailing on a great circle, and ſhewn how to draw the rhumbs on a globe mechanically, ſets down Wright's two tables of latitude and of rhumbs, in order to deſcribe theſe lines more accurately, pretending even to have diſcovered an error in Wright's table. But all Stevin's objections were fully anſwered by the author himſelf, who ſhowed that they aroſe from the groſs way of calculating made uſe of by the former.

In 1624, the learned Wellebrordus Snellius, profeſſor of mathematics at Leyden, publiſhed a treatiſe of navigation on Wright's plan, but ſomewhat obſcurely; and as he did not particularly mention all the diſcoveries of Wright, the latter was thought by ſome to have taken the hint of all his diſcoveries from Snellius. But this ſuppoſition is long ago refuted; and Wright enjoys the honour of thoſe diſcoveries which is juſtly his due.

Mr Wright having ſhown how to find the place of the ſhip on his chart, obſerved that the ſame might be performed more accurately by calculation: but conſidering, as he ſays, that the latitudes, and eſpecially the courſes at ſea, could not be determined ſo preciſely, he forbore ſetting down particular examples; as the mariner may be allowed to ſave himſelf this trouble, and only mark out upon his chart the ſhip's way after the manner then uſually practiſed. However, in 1614, Mr Raphe Handſon, among his nautical queſtions ſubjoined to a tranſlation of Pitiſcus's trigonometry, ſolved very diſtinctly every caſe of navigation, by applying arithmetical calculations to Wright's table of latitudes, or of meridional parts, as it hath ſince been called. Though the method diſcovered by Wright for finding the change of longitude by a ſhip ſailing on a rhumb is the proper way of performing it, Handſon alſo propoſes two ways of approximation to it without the aſſiſtance of Wright's diviſion of the meridian line. The firſt was computed by the arithmetical mean between the co-ſines of both latitudes; the other by the ſame mean between the ſecants as an alternative, when Wright's book was not at hand; tho' this latter is wider from the truth than the firſt. By the ſame calculations alſo he ſhowed how much each of theſe compendiums deviates from the truth, and alſo how widely the computations on the erroneous principles of the plane chart differ from them all. The method, however, commonly uſed by our ſailors is commonly called the *middle latitude;* which, though it errs more than that by the arithmetical mean between the two co-ſines, is preferred on account of its being leſs operoſe: yet in high latitudes it is more eligible to uſe that of the arithmetical mean between the logarithmic co-ſines, equivalent to the geometrical mean between the co-ſines themſelves; a method ſince propoſed by Mr John Baſſat. The computation by the middle latitude will always fall ſhort of the true change of longitude; that by the geometrical mean will always exceed; but that by the arithmetical mean falls ſhort in latitudes above 45 degrees, and exceeds in leſſer latitudes. However, none of theſe methods will differ much from the truth when the change of latitude is ſufficiently ſmall.

About this time logarithms were invented by John Napier, baron of Merchiſtoun in Scotland, and proved of the utmoſt ſervice to the art of navigation. They were firſt applied by Mr Edward Gunter in 1620. He conſtructed a table of artificial ſines and tangents to every minute of the quadrant. Theſe were applied according to Wright's table of meridional parts, and have been found extremely uſeful in other branches of the mathematics. He contrived alſo a moſt excellent ruler, commonly known by the name of *Gunter's ſcale*, on which were inſcribed the logarithmic lines for numbers, and for ſines and tangents of arches *. He alſo greatly improved the ſector for the ſame purpoſes. He ſhewed alſo how to take a back-obſervation by the croſs-ſtaff, whereby the error ariſing from the excentricity of the eye is avoided. He deſcribed likewiſe another inſtrument of his own invention, called the *croſs-bow*, for taking altitudes of the ſun or ſtars, with ſome contrivances for the more ready collecting the latitude from the obſervation. The diſcoveries concerning the logarithms were carried to France in 1624 by Mr Edmund Wingate, who publiſhed two ſmall tracts in that year at Paris. In one of theſe he taught the uſe of Gunter's ſcale; and in the other, of the tables of artificial ſines and tangents, as modelled according to Napier's laſt form, erroneouſly attributed by Wingate to Briggs.

* See *Gunter's Scale*.

Gunter's ruler was projected into a circular arch by the reverend Mr William Oughtred in 1633, and its uſes fully ſhown in a pamphlet intitled, *The circles of proportion;* where, in an appendix, are well handled ſeveral important points in navigation. It has alſo been made in the form of a ſliding ruler.

The logarithmic tables were firſt applied to the different caſes of ſailing by Mr Thomas Addiſon, in his treatiſe intitled, *Arithmetical navigation*, printed in 1625. He alſo gives two traverſe tables, with their uſes; the one to quarter points of the compaſs, the other to degrees. Mr Henry Gellibrand publiſhed his diſcovery of the changes of the variation of the compaſs, in a ſmall quarto pamphlet, intitled, *A diſcourſe mathematical on the variation of the magnetical needle*, printed in 1635. This extraordinary phenomenon he found out by comparing the obſervations made at different times near the ſame place by Mr Burrough, Mr Gunter, and himſelf, all perſons of great ſkill and experience in theſe matters. This diſcovery was likewiſe ſoon known abroad; for Father Athanaſius Kircher, in his treatiſe intitled, *Magnes*, firſt printed at Rome in 1641, informs us, that he had been told it by Mr John Greaves; and then gives a letter of the famous Marinus Merſennus, containing a very diſtinct account of the ſame.

As altitudes of the ſun are taken on ſhipboard by obſerving his elevation above the viſible horizon, to collect from thence the ſun's true altitude with correctneſs, Wright obſerves it to be neceſſary that the dip of the horizon below the obſerver's eye ſhould be brought into the account, which cannot be calculated without knowing the magnitude of the earth. Hence he was induced to propoſe different methods for finding this; but complains that the moſt effectual was out

of

of his power to execute; and therefore contented himself with a rude attempt, in some measure sufficient for his purpose: and the dimensions of the earth deduced by him corresponded so well with the usual divisions of the log-line, that as he writ not an express treatise on navigation, but only for the correcting such errors as prevailed in general practice, the log-line did not fall under his notice. Mr Richard Norwood, however, put in execution the method recommended by Mr Wright as the most perfect for measuring the dimensions of the earth, with the true length of the degrees of a great circle upon it; and, in 1635, he actually measured the distance between London and York; from whence, and the summer solstitial altitudes of the sun observed on the meridian at both places, he found a degree on a great circle of the earth to contain 367,196 English feet, equal to 57,300 French fathoms or toises: which is very exact, as appears from many measures that have been made since that time. Of all this Mr Norwood gave a full account in his treatise called *The seaman's practice*, published in 1637. He there shows the reason why Snellius had failed in his attempt; he points out also various uses of his discovery, particularly for correcting the gross errors hitherto committed in the divisions of the log-line. These necessary amendments, however, were little attended to by the sailors, whose obstinacy in adhering to established errors has been complained of by the best writers on navigation; but at length they found their way into practice, and few navigators of reputation now make use of the old measure of 42 feet to a knot. In that treatise also Mr Norwood describes his own excellent method of setting down and perfecting a sea-reckoning, by using a traverse table; which method he had followed and taught for many years. He shows also how to rectify the course by the variation of the compass being considered; as also how to discover currents, and to make proper allowance on their account. This treatise, and another on trigonometry, were continually reprinted, as the principal books for learning scientifically the art of navigation. What he had delivered, especially in the latter of them, concerning this subject, was contracted as a manual for sailors, in a very small piece called his *Epitome*; which useful performance has gone through a great number of editions. No alterations were ever made in the Seaman's Practice till the 12th edition in 1676, when the following paragraph was inserted in a smaller character: "About the year 1672, Monsieur Picart has published an account in French, concerning the measure of the earth, a breviate whereof may be seen in the Philosophical Transactions, n° 112; wherein he concludes one degree to contain 365,184 English feet, nearly agreeing with Mr Norwood's experiment;" and this advertisement is continued through the subsequent editions as late as the year 1732. About the year 1645, Mr Bond published in Norwood's epitome a very great improvement in Wright's method by a property in his meridian line, whereby its divisions are more scientifically assigned than the author himself was able to effect; which was from this theorem, that these divisions are analogous to the excesses of the logarithmic tangents of half the respective latitudes augmented by 45 degrees above the logarithm of the radius. This he afterwards explained more fully in the third edition of Gunter's works, printed in 1653; where, after observing that the logarithmic tangents from 45° upwards increase in the same manner that the secants added together do; if every half degree be accounted as a whole degree of Mercator's meridional line. His rule for computing the meridional parts belonging to any two latitudes, supposed on the same side of the equator, is to the following effect. "Take the logarithmic tangent, rejecting the radius, of half each latitude, augmented by 54 degrees; divide the difference of those numbers by the logarithmic tangent of 50° 30′, the radius being likewise rejected; and the quotient will be the meridional parts required, expressed in degrees." This rule is the immediate consequence from the general theorem, That the degrees of latitude bear to one degree, (or 60 minutes, which in Wright's table stands for the meridional parts of one degree), the same proportion as the logarithmic tangent of half any latitude augmented by 45 degrees, and the radius neglected, to the like tangent of half a degree augmented by 45 degrees, with the radius likewise rejected. But here was farther wanting the demonstration of this general theorem, which was at length supplied by Mr James Gregory of Aberdeen, in his *Exercitationes Geometricæ*, printed at London in 1668; and afterwards more concisely demonstrated, together with a scientific determination of the divisor, by Dr Halley in the Philosophical Transactions for 1695, n° 219. from the consideration of the spirals into which the rhumbs are transformed in the stereographic projection of the sphere upon the plane of the equinoctial; and which is rendered still more simple by Mr Roger Cotes, in his Logometria, first published in the Philosophical Transactions for 1714, n° 388. It is moreover added in Gunter's book, that if $\frac{1}{10}$ of this division, which does not sensibly differ from the logarithmic tangent of 45° 1′ 30″ (with the radius subtracted from it), be used, the quotient will exhibit the meridional parts expressed in leagues: and this is the divisor set down in Norwood's Epitome. After the same manner the meridional parts will be found in minutes, if the like logarithmic tangent of 45° 1′ 30″, diminished by the radius, be taken; that is, the number used by others being 12633, when the logarithmic tables consist of eight places of figures besides the index. In an edition of the seaman's kalendar, Mr Bond declared, that he had discovered the longitude by having found out the true theory of the magnetic variation; and to gain credit to his assertion, he foretold, that at London, in 1657, there would be no variation of the compass, and from that time it would gradually increase the other way; which happened accordingly. Again, in the Philosophical Transactions for 1668, n° 40. he published a table of the variation for 49 years to come. Thus he acquired such reputation, that his treatise, intitled, *The longitude found*, was, in 1676, published by the special command of Charles II. and approved by many celebrated mathematicians. It was not long, however, before it met with opposition; and, in 1678, another treatise, intitled, *The longitude not found*, made its appearance; and as Mr Bond's hypothesis did not in any manner answer its author's sanguine expectations, the affair was undertaken by Dr Halley. The result of his speculations was, that the magnetic needle is influenced

influenced by four poles; but this wonderful phenomenon feems hitherto to have eluded all our refearches. In 1700, however, Dr Halley publifhed a general map, with curve lines expreffing the paths where the magnetic needle had the fame variation; which was received with univerfal applaufe. But as the pofitions of thefe curves vary from time to time, they fhould frequently be corrected by fkilful perfons; as was done in 1744 and 1756, by Mr William Mountaine, and Mr James Dodfon, F. R. S. In the Philofophical Tranfactions for 1690, Dr Halley alfo gave a differtation on the monfoons; containing many very ufeful obfervations for fuch as fail to places fubject to thefe winds.

After the true principles of the art were fettled by Wright, Bond, and Norwood, the authors on navigation became fo numerous, that it would be impoffible to enumerate them; and every thing relative to it was fettled with an accuracy not only unknown to former ages, but which would have been reckoned utterly impoffible. The earth being found to be a fpheroid, and not a perfect fphere, with the fhorteft diameter paffing through the poles, a tract was publifhed in 1741 by the Rev. Dr Patrick Murdoch, wherein he accommodated Wright's failing to fuch a figure; and Mr Colin Maclaurin, the fame year, in the Philofophical Tranfactions, n° 461, gave a rule for determining the meridional parts of a fpheroid; which fpeculation is farther treated of in his book of Fluxions, printed at Edinburgh in 1742.

Among foreign nations alfo many treatifes were now publifhed; but excepting the remarkable difcovery of the longitude by Mr Harrifon, no confiderable improvement hath been made any-where. Indeed, the fubject hath been fo much canvaffed and ftudied by men of learning and ingenuity in all nations, that there feems to be little room for farther improvements; and the art of navigation feems to be nearly brought to as much perfection as it is capable of.

PART I. THEORY OF NAVIGATION.

THE motion of a fhip in the water is well known to depend on the action of the wind upon its fails, regulated by the direction of the helm. As the water is a refifting medium, and the bulk of the fhip very confiderable, it thence follows, that there is always a great refiftance on her fore-part; and when this refiftance becomes fufficient to balance the moving force of the wind upon the fails, the fhip attains her utmoft degree of velocity, and her motion is no longer accelerated. This velocity is different according to the different ftrength of the wind: but the ftronger the wind, the greater refiftance is made to the fhip's paffage through the water; and hence, though the wind fhould blow ever fo fiercely, there is alfo a limit to the velocity of the fhip: for the fails and ropes can bear but a certain force of air; and when the refiftance on the fore-part becomes more than equivalent to their ftrength, the velocity can be no longer increafed, and the tackle gives way.

The direction of a fhip's motion depends on the fituation of her fails with regard to the wind. The moft natural and eafy pofition is, when fhe runs directly before it; but this is not often the cafe, on account of the variable nature of the winds, and the fituations of the different ports to which the fhip may be bound. When the wind therefore happens not to be favourable, the rudder and fails muft be managed in fuch a manner that the fhip may make an angle with the direction of the current of air, as reprefented Plate CCI. fig. 4. Thus, fuppofing a fhip at D, bound for the port B. Suppofing DG the length of the keel, it muft be kept by the rudder in fuch a pofition as to make the acute angle EDB with the direction of the wind. If, when fke arrives at B, it is required to fail to another port A, the keel muft be kept in the pofition BF; and thus, by continually making the angle EBA with the direction of the wind, fhe will arrive at the defired port: and in this manner may a fhip be fteered to any other port, fuppofe to C or H.

The reafon of the fhip's motion in thefe cafes is, that the water refifts the fide more than the fore-part, and that in the fame proportion that her length exceeds her breadth. This proportion is fo confiderable, that the fhip continually flies off where the refiftance is leaft, and that fometimes with great fwiftnefs. In this way of failing, however, there is a great limitation: for if the angle made by the keel with the direction of the wind be too acute, the fhip cannot be kept in that pofition; neither is it poffible for a large fhip to make a more acute angle with the wind than $67\frac{1}{2}$ degrees; though fmall floops, it is faid, may make an angle of 56 or 57 degrees with it. In all thefe cafes, however, the velocity of the fhip is greatly retarded; and not only on account of the obliquity of her motion, but by reafon of what is called her *lee-way*. This is occafioned by the yielding of the water on the lee-fide of the fhip, by which means the veffel acquires a compound motion, partly in the direction of the wind, and partly in that which is neceffary for attaining the defired haven. Thus, fuppofing a fhip to fet out from B, in the direction BA, the force of the wind will have fuch an impreffion upon her, that, inftead of keeping the ftraight path BFFF, fhe will follow that of B*abc*, &c. and thus will fall fhort of her intended port by fome confiderable fpace, as A*f*.

It is perhaps impoffible to lay down any mathematical principles on which the lee-way of a fhip could be properly calculated; only we may fee in general that it depends on the ftrength of the wind, the roughnefs of the fea, and the velocity of the fhip. When the wind is not very ftrong, the refiftance of the water on the lee-fide bears a very great proportion to that of the current of air; and therefore it will yield but very little: however, fuppofing the fhip to remain in the fame place, it is evident, that the water having once begun to yield will continue to do fo for fome time, even though no additional force was applied to it; but as the wind continually applies the fame force as at firft, the lee-way of the fhip muft go on conftantly increafing till the refiftance of the water

Theory. on the lee fide balances the force applied on the other, when it will become uniform, as doth the motion of a fhip failing before the wind. If the fhip changes her place with any degree of velocity, then every time fhe moves her own length, a new quantity of water is to be put in motion, which hath not yet received any momentum, and which of confequence will make a greater refiftance than it can do when the fhip remains in the fame place. In proportion to the fwiftnefs of the fhip, then, the lee-way will be the lefs: but if the wind is very ftrong, the velocity of the fhip bears but a fmall proportion to that of the current of air; and the fame effects muft follow as though the fhip moved flowly, and the wind was gentle; that is, the fhip muft make a great deal of lee-way.—The fame thing happens when the fea rifes high, whether the wind is ftrong or not; for then the whole water of the ocean, as far as the fwell reaches, hath acquired a motion in a certain direction, and that to a very confiderable depth. The mountainous waves will not fail to carry the fhip very much out of her courfe; and this deviation will certainly be according to their velocity and magnitude. In all cafes of a rough fea, therefore, a great deal of lee-way is made.—Another circumftance alfo makes a variation in the quantity of the lee-way; namely, the lightnefs or heavinefs of the fhip; it being evident, that when the fhip finks deep in the water, a much greater quantity of that element is to be put in motion before fhe can make any lee-way, than when fhe fwims on the furface. As therefore it is impoffible to calculate all thefe thing with mathematical exactnefs, it is plain that the real courfe of a fhip is exceedingly difficult to be found, and frequent errors muft be made, which only can be corrected by celeftial obfervations.

In many places of the ocean there are *currents*, or places where the water, inftead of remaining at reft, runs with a very confiderable velocity for a great way in fome particular direction, and which will certainly carry the fhip greatly out of her courfe. This occafions an error of the fame nature with the lee-way; and therefore, whenever a current is perceived, its velocity ought to be determined, and the proper allowances made.

Another fource of error in reckoning the courfe of a fhip proceeds from the variation of the compafs. There are few parts of the world where the needle points exactly north; and in thofe where the variation is known, it is fubject to very confiderable alterations. By thefe means the courfe of the fhip is miftaken; for as the failors have no other ftandard to direct them than the compafs, if the needle, inftead of pointing due north, fhould point north-eaft, a prodigious error would be occafioned during the courfe of the voyage, and the fhip would not come near the port to which fhe was bound. To avoid errors of this kind the only method is, to obferve the azimuths as frequently as poffible, by which the difference of variation will be perceived, and the proper allowances can then be made for errors in the courfe which this may have occafioned.

Errors will arife in the reckoning of a fhip, efpecially when fhe fails in high latitudes, from the fpheroidal figure of the earth; for as the polar diameter of our globe is found to be confiderably fhorter than the equatorial one, it thence follows, that the farther we remove from the equator the longer are the degrees of latitude. Of confequence, if a navigator affigns any certain number of miles for the length of a degree of latitude near the equator, he muft vary that meafure as he approaches towards the poles, otherwife he he will imagine that he hath not failed fo far as he actually hath done. It would therefore be neceffary to have a table containing the length of a degree of latitude in every different parallel from the equator to either pole; as without this a troublefome calculation muft be made at every time the navigator makes a reckoning of his courfe. Such a table, however, hath not yet appeared; neither indeed feems it to be eafy to make it, on account of the difficulty of meafuring the length even of one or two degrees of latitude in different parts of the world. Sir Ifaac Newton firft difcovered this fpheroidal fhape of the earth; and fhewed, from experiments on pendulums, that the polar diameter was to the equatorial one as 229 to 230. This proportion, however, hath not been admitted by fucceeding calculators. The French mathematicians who meafured a degree on the meridian in Lapland, made the proportion between the equatorial and polar diameters to be as 1 to 0.9891. Thofe who meafured a degree at Quito in Peru, made the proportion 1 to 0.99624, or 266 to 265. M. Bouquer makes the proportion to be as 179 to 178; and M. Buffon, in one part of his theory of the earth, makes the equatorial diameter exceed the polar one by $\frac{1}{181}$ of the whole. From thefe variations it appears that the point is not exactly determined, and confequently that any corrections which can be made with regard to the fpheroidal figure of the earth muft be very uncertain.

It is of confequence to navigators in a long voyage to take the neareft way to their port; but this can feldom be done without confiderable difficulty. The fhorteft diftance between any two points of a fphere is meafured by an arch of a great circle intercepted between them; and therefore, excepting where both places lie under the fame parallel of latitude, it is adsifeable to direct the fhip along a great circle of the earth's furface. But this is a matter of confiderable difficulty, becaufe there are no fixed marks by which it can be readily known whether the fhip fails in the direction of a great circle or not. For this reafon the failors commonly choofe to direct their courfe by the rhumbs, or the bearing of the place by the compafs. Thefe bearings do not point out the fhorteft diftance between places; becaufe, on a globe, the rhumbs are fpirals, and not arches of great circles. However, when the places lie directly under the equator, or exactly under the fame meridian, the rhumb then coincides with the arch of a great circle, and of confequence fhews the neareft way. The failing on the arch of a great circle is called *great circle failing*; and the cafes of it depend all on the folution of problems in fpheric trigonometry.

Fig. 1. NEPERS RODS

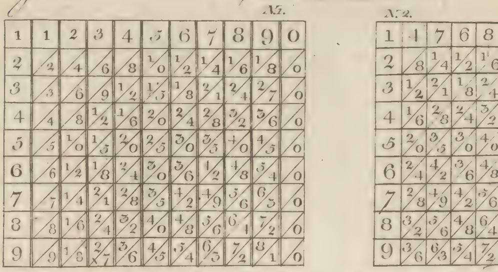


Fig. 6.

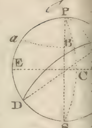


Fig. 7.

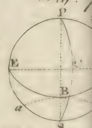


Fig. 2. NOCTURNAL.

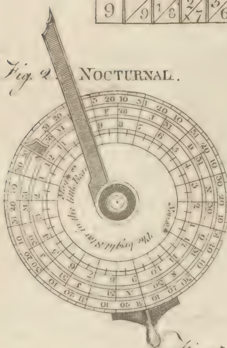


Fig. 4.

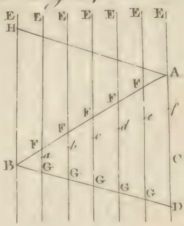


Fig. 3. OLIVE PRESS

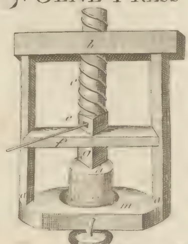


Fig. 5.

Fig. 8.

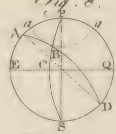


Fig. 9.

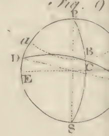


Fig. 10.

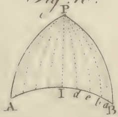
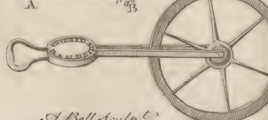


Fig. 11.
PERAMBULATOR



A. Bell Sculp.t

PART II. PRACTICE OF NAVIGATION.

THE main end of all practical navigation is to conduct the ſhip in ſafety to her deſtined port; and for this purpoſe it is of the utmoſt conſequence to know in what particular part of the ſurface of the globe ſhe is at any particular time. This can only be done by having an accurate map of the ſea-coaſts of all the countries of the world, and, by tracing out the ſhip's progreſs along the map, to know at what time ſhe approaches the deſired haven, or how ſhe is to direct her courſe in order to reach it. It is therefore a matter of great importance for navigators to be furniſhed with maps, or *charts*, as they are called, not only very accurate in themſelves, but ſuch as are capable of having the ſhip's courſe eaſily traced upon them, without the trouble of laborious calculations, which are ready to create miſtakes.—The names of the two great diviſions of navigation are taken merely from the kind of charts made uſe of. Plane ſailing is that in which the plane chart is made uſe of; and Mercator's ſailing, or globular ſailing, is that in which Mercator's chart is uſed. In both theſe methods, it is eaſy to find the ſhip's place with as great exactneſs as the chart will allow, either by the ſolution of a caſe in plane trigonometry, or by geometrical conſtruction.

§ 1. *Of Plane ſailing.*

As a neceſſary preliminary to our underſtanding this method of navigation, we ſhall here give the conſtruction of the plane chart.

1. This chart ſuppoſes the earth to be a plane, and the meridians parallel to one another; and likewiſe the parallels of latitude at equal diſtance from one another, as they really are upon the globe. Tho' this method be in itſelf evidently falſe; yet, in a ſhort run, and eſpecially near the equator, an account of the ſhip's way may be kept by it tolerably well.

Having determined the limits of the chart, that is, how may degrees of latitude and longitude, or meridional diſtance (they being in this chart the ſame), it is to contain: ſuppoſe from the lat. of 20° N. to the lat. of 71° N.; and from the longitude of London in 0. deg. to the lon. of 50° W.; then chooſe a ſcale of equal parts, by which the chart may be contained within the ſize of the ſheet of paper on which it is intended to be drawn. In the chart annexed, the ſcale is ſuch, that each degree of latitude and longitude is $\frac{1}{8}$ part of an inch.

Plate CCI. fig. 5. Make a parallelogram ABCD, the length of which AB from north to ſouth ſhall contain 51 degrees, the difference of latitude between the limits of 20° and 71°; and the breadth AD from eaſt to weſt ſhall contain the propoſed 50 degrees of longitude, the degrees being taken from the ſaid ſcale of 8 degrees to an inch; and this parallelogram will be the boundaries of the chart.

About the boundaries of the chart make ſcales containing the degrees, halves and quarters of degrees (if the ſcale is large enough); drawing lines acroſs the chart thro' every 5 or 10 degrees; let the degrees of latitude and longitude have their reſpective numbers annexed, and the ſheet is then fitted to receive the places intended to be delineated thereon.

On a ſtrait ſlip of paſteboard, or ſtiff paper, let the ſcale of the degrees and parts of degrees of longitude, in the line AD, be laid cloſe to the edge; and the diviſions numbered from the right hand towards the left, being all weſt longitude.

Seek in a geographical table for the latitudes and longitudes of the places contained within the propoſed limits; and let them be written out in the order in which they increaſe in latitude.

Then, to lay down any place, lay the edge of the paſteboard ſcale to the diviſions on each ſide the chart, ſhewing the latitude of the place; ſo that the beginning of its diviſions fall on the right-hand border AB; and againſt the diviſion ſhewing the longitude of the given place make a point, and this gives the poſition of the place propoſed; and in like manner are all the other places to be laid down.

Draw waving lines from one point to the other, where the coaſt is contiguous, and thus the repreſentation of the lands within the propoſed limits will be delineated.

Write the names to the reſpective parts, and in ſome convenient place inſert a compaſs, and the chart will be completed.

2. The angle formed by the meridian and rhumb that a ſhip ſails upon, is called the *ſhip's courſe.* Thus if a ſhip ſails on the NNE rhumb, then her courſe will be 22° 30′; and ſo of others.

3. The diſtance between two places lying on the ſame parallel counted in miles of the equator, or the diſtance of one place from the meridian of another counted as above on the parallel paſſing over that place, is called *meridional diſtance;* which, in plane ſailing, goes under the name of *departure.*

4. Let A (n° 3.) denote a certain point on the earth's ſurface, AC its meridian, and AD the parallel of latitude paſſing through it; and ſuppoſe a ſhip to ſail from A on the NNE rhumb till ſhe arrive at B; and through B draw the meridian BD, (which, according to the principles of plane ſailing, muſt be parallel to CA,) and the parallel of latitude BC: then the length of AB, viz. how far the ſhip has ſailed upon the NNE rhumb, is called her *diſtance;* AC or BD will be her difference of latitude, or northing; CB will be her departure, or eaſting; and the angle CAB will be the courſe. Hence it is plain, that the diſtance ſailed will always be greater than either the difference of latitude or departure; it being the hypothenuſe of a right-angled triangle, whereof the other two are the legs; except the ſhip ſails either on a meridian or a parallel of latitude: for if the ſhip ſails on a meridian, then it is plain, that her diſtance will be juſt equal to her difference of latitude, and ſhe will have no departure; but if ſhe ſail on a parallel, then her diſtance will be the ſame with her departure, and ſhe will have no difference of latitude. It is evident alſo from the figure, that if the courſe be leſs than 4 points, or 45 degrees, its complement, viz. the other oblique angle, will be greater than 45 degrees, Plate CCII.

and fo the difference of latitude will be greater than the departure; but if the courfe be greater than 4 points, then the difference of latitude will be lefs than the departure; and laftly, if the courfe be juft 4 points, the difference of latitude will be equal to the departure.

5. Since the diftance, difference of latitude, and departure, form a right-angled triangle, in which the oblique angle oppofite to the departure is the courfe, and the other its complement; therefore, having any two of thefe given, we can (by plain trigonometry) find the reft; and hence arife the cafes of plane-failing, which are as follow.

Case I. Courfe and diftance given, to find difference of latitude and departure.

Example. Suppofe a fhip fails from the latitude of 30° 25′ north, NNE, 32 miles, (n° 4.): Required the difference of latitude and departure, and the latitude come to. Then (by right-angle trigonometry,) we have the following analogy, for finding the departure, *viz.*

As radius - - -		10.00000
to the diftance AC -	32 -	1.50515
fo is the fine of the courfe A	22°, 30′ -	9.58284
to the departure BC -	12.25 -	1.08799

fo the fhip has made 12.25 miles of departure eafterly, or has got fo far to the eaftward of her meridian. Then for the difference of latitude or northing the fhip has made, we have (by rectangular trigonometry) the following analogy, *viz.*

As radius - - -		10.00000
is to the diftance AC -	32 -	1.50515
fo is the co-fine of courfe A	22° 30′	9.58284
to the difference of lat. AB	29.57	1.47077

fo the fhip has differed her latitude, or made of northing, 29.57 minutes.

And fince her former latitude was north, and her difference of latitude alfo north; therefore,

To the latitude failed from -	30°, 25′ N
add the difference of latitude -	00°, 29. 57
and the fum is the latitude come to	30°, 54.57 N

By this cafe are calculated the tables of difference of latitude, and departure, to every degree, point, and quarter-point of the compafs.

Case II. Courfe and difference of latitude given, to find diftance and departure.

Example. Suppofe a fhip in the latitude of 45° 25′ north, fails NE*b*N½ eafterly (n° 5.) till fhe come to the latitude of 46° 55′ north: Required the diftance and departure made good upon that courfe.

Since both latitudes are northerly, and the courfe alfo northerly; therefore,

From the latitude come to -	46°, 55′
fubtract the latitude failed from -	45°, 25′
and there remains - -	01°, 30′
the difference of latitude, equal to -	90 miles.

And (by rectangular trigonometry) we have the following analogy, for finding the departure BD, *viz.*

As radius - - -		10.00000
is to the diff. of latitude AB -	90 -	1.95424
fo is the tangent of courfe A -	39°, 22′	9.91404
to the departure BD -	73 84	1.86828

fo the fhip has got 73.84 miles to the eaftward of her fomer meridian.

Again, for the diftance AD, we have (by rectangular trigonometry) the following proportion, *viz.*

As radius - - -		10.00000
is to the fecant of the courfe	39°, 22′	10.11176
fo is the difference of latitude AB	90 -	1.95424
to the diftance AD -	116.4	2.06600

Case III. Difference of latitude and diftance given, to find courfe and departure.

Example. Suppofe a fhip fails from the latitude of 56° 50′ north, on a rhumb between fouth and weft, 126 miles, and fhe is then found by obfervation to be in the latitude of 55° 40′ north: Required the courfe fhe failed on, and her departure from the meridian. N° 6.

Since the latitudes are both north, and the fhip failing towards the equator; therefore,

From the latitude failed from -	56°, 50′
fubtract the obferved latitude -	55°, 10′
and the remainder - -	01°, 40′

equal to 70 miles, is the difference of latitude.

By rectangular trigonometry we have the following proportion for finding the angle of the courfe F, *viz.*

As the diftance failed DF -	126 -	2.10037
is to radius - - -		10.00000
fo is the diff. of latitude FD -	70 -	1.84510
to the co-fine of the courfe F -	56°, 15′	9.74473

which, becaufe fhe fails between fouth and weft, will be fouth 56° 15′ weft, or SW*b*W. Then, for the departure, we have (by rectangular trigonometry) the following proportion, *viz.*

As radius - - -		10.00000
is to the diftance failed DF -	126 -	2.10037
fo is the fine of the courfe F -	56°, 15′	9.91985
to the departure DE -	104.8 -	2.02022

confequently fhe has made 104.8 miles of departure wefterly.

Case IV. Difference of latitude and departure given, to find courfe and diftance.

Example. Suppofe a fhip fails from the latitude of 44° 50′ north, between fouth and eaft, till fhe has made 64 miles of eafting, and is then found by obfervation to be in the latitude of 42° 56′ north: Required the courfe and diftance made good.

Since the latitudes are both north, and the fhip failing towards the equator; therefore,

From the latitude failed from -	44°, 50′N
take the latitude come to - -	42°, 56′
and there remains - -	01°, 54′

equal to 114 miles, the difference of latitude or fouthing.

In this cafe (by rectangular trigonometry) we have the following proportion to find the courfe KGL (N° 7.) *viz.*

As the diff. of latitude GK 114	-	2.05690
is to radius - -	-	10.00000
fo is the departure KL -	64 -	1.80618
to the tangent of courfe G -	29°, 19′ -	9.74928

which, becaufe the fhip is failing between fouth and eaft, will be fouth 29° 19′ eaft, or SSE ½ eaft nearly.

Then for the diftance, we fhall have (by rectangular trigonometry) the following analogy, *viz.*

As

As radius	- - -		10.00000
is to the diff. of latitude GK	114	-	2.05690
ſo is the ſecant of the courſe	-	29°, 19'	10.05952
to the diſtance GL	-	130.8 -	2.11642

conſequently the ſhip has ſailed on a SSE $\frac{1}{2}$ eaſt courſe 130.8 miles.

Case V. Diſtance and departure given, to find courſe and difference of latitude.

Example. Suppoſe a ſhip at ſea ſails from the latitude of 34° 24' north, between north and weſt 124 miles, and is found to have made of weſting 86 miles: Required the courſe ſteered, and the difference of latitude or northing made good.

In this caſe (by rectangular trigonometry) we have the following proportion for finding the courſe ADB, (N° 8.) *viz.*

As the diſtance AD	-	124 -	2.09342
is to radius	- -	-	10.00000
ſo is the departure AB	-	86 -	1.93450
to the ſine of the courſe D	43° 54'	-	9.84108

ſo the ſhip's courſe is north 33° 45' weſt, or NW*b*N $\frac{1}{4}$ weſt nearly.

Then for the difference of latitude, we have (by rectangular trigonometry) the following analogy, *viz.*

As radius	- -	-	10.00000
is to the diſtance AD	-	124 -	2.09342
ſo is the co-ſine of the courſe	43°, 54'	-	9.85766
to the diff. of latitude BD	-	89.35 -	1.95108

which is equal to 1 degree and 29 minutes nearly.

Hence, to find the latitude the ſhip is in, ſince both latitudes are north, and the ſhip ſailing from the equator; therefore,

To the latitude ſailed from	34°, 24'
add the difference of latitude	1°, 29'
the ſum is	35°, 53

the latitude the ſhip is in north.

Case VI. Courſe and departure given, to find diſtance and difference of latitude.

Example. Suppoſe a ſhip at ſea, in the latitude of 24° 30' ſouth, ſails SE*b*S, till ſhe has made of eaſting 96 miles: Required the diſtance and difference of latitude made good on that courſe.

In this caſe (by rectangular trigonometry and by caſe 2.) we have the following proportion for finding the diſtance, (N° 9.) *viz.*

As the ſine of the courſe G	33°, 45'	-	9.74474
is to the departure HM	-	96 -	1.98227
ſo is radius	-	-	10.00000
to the diſtance GM	-	172.8 -	2.23753

Then, for the difference of latitude, we have (by rectangular trigonometry) the following analogy, *viz.*

As the tangent of courſe	-	33°, 45' -	9.82489
is to the departure HM	-	96 -	1.98227
ſo is radius	-	-	10.00000
to the difference of latitude GH	-	143.7 -	2.15738

equal to 2°, 24' nearly. Conſequently, ſince the latitude the ſhip failed from was ſouth, and ſhe ſailing ſtill towards the ſouth,

To the latitude ſailed from	24°, 30'
add the difference of latitude	2°, 24'
and the ſum	26°, 54

is the latitude ſhe is come to ſouth.

6. When a ſhip ſails on ſeveral courſes in 24 hours, the reducing all theſe into one, and thereby finding the courſe and diſtance made good upon the whole, is commonly called the *reſolving of a traverſe.*

7. At ſea they commonly begin each day's reckoning from the noon of that day, and from that time they ſet down all the different courſes and diſtances ſailed by the ſhip till noon next day upon the log-board; then from theſe ſeveral courſes and diſtances, they compute the difference of latitude and departure for each courſe (by *Caſe* 1. *of Plane Sailing;*) and theſe, together with the courſes and diſtances, are ſet down in a table, called the *traverſe table*, which conſiſts of five columns: in the firſt of which are placed the courſes and diſtances; in the two next, the differences of latitude belonging to theſe courſes, according as they are north or ſouth; and in the two laſt are placed the departures belonging to theſe courſes, according as they are eaſt or weſt. Then they ſum up all the northings and all the ſouthings; and taking the difference of theſe, they know the difference of latitude made good by the ſhip in the laſt 24 hours, which will be north or ſouth, according as the ſum of the northings or ſouthings is greateſt: the ſame way, by taking the ſum of all the eaſtings, and likewiſe of all the weſtings, and ſubtracting the leſſer of theſe from the greater, the difference will be the departure made good by the ſhip laſt 24 hours, which will be eaſt or weſt according as the ſum of the eaſtings is greater or leſs than the ſum of the weſtings; then from the difference of latitude and departure made good by the ſhip laſt 24 hours, found as above, they find the true courſe and diſtance made good upon the whole (by *Caſe* 4. *of Plane Sailing*), as alſo the courſe and diſtance to the intended port.

Example. Suppoſe a ſhip at ſea, in the latitude of 48° 24' north at noon any day, is bound to a port in the latitude of 43° 40' north, whoſe departure from the ſhip is 144 miles eaſt; conſequently the direct courſe and diſtance of the ſhip is SSE $\frac{1}{4}$ eaſt 315 miles; but by reaſon of the ſhifting of the winds ſhe is obliged to to ſteer the following courſes till noon next day, *viz.* SE*b*S 56 miles, SSE 64 miles, NW*b*W 48 miles, S*b*W $\frac{1}{4}$ weſt 54 miles, and SE*b*S $\frac{1}{4}$ eaſt 74 miles: Required the courſe and diſtance made good the laſt 24 hours, and the bearing and diſtance of the ſhip from the intended port.

The ſolution of this traverſe depends entirely on the 1ſt and 4th *Caſes of Plane Sailing;* and firſt we muſt (by *Caſe* 1.) find the difference of latitude and departure for each courſe. Thus,

1 Courſe SE*b*S diſtance 56 miles.

For departure.

As radius	-	-	10.00000
is to the diſtance	- 56	-	1.74819
ſo is the ſine of the courſe	33°, 45'	-	9.74474
to the departure	- 31.11	-	1.49293

For difference of latitude.

As radius	-	-	10.00000
is to the diſtance	-	56 -	1.74819
ſo is the co-ſine of the courſe		33°, 45'	9.91985
to the diff. of latitude	-	46.57 -	1.66804

2. Courſe SSE and diſtance 64 miles.

For departure.

As radius	-	-	10.00000
is to the diſtance	-	64 -	1.80618
ſo is the ſine of the courſe	-	22°, 30'	9.58284

to

PRACTICE.

to the departure	-	24.5 -	1.38902

For difference of latitude.

As radius	-	-	10.00000
is to the diftance	-	64 -	1.80618
fo is the co-fine of the courfe		22°, 30'	9.96562
to the difference of latitude	-	59.13 -	1.77180

3. Courfe NW*b*W and diftance 48 miles.

For departure.

As radius	-	-	10.00000
is to the diftance	-	48 -	1.68124
fo is the fine of the courfe	-	56°, 15'	9.91985
to the departure	-	39.91 -	1.60109

For difference of latitude.

As radius	-	-	10.00000
is to the diftance	-	48 -	1.68124
fo is the co-fine of the courfe		56°, 15'	9.74474
to the difference of latitude	-	26.67	1.42598

4. Courfe S*b*W ½ weft and diftance 54 miles.

For departure.

As radius	-	-	10.00000
is to the diftance	-	54 -	1.73239
fo is the fine of the courfe		16°, 52'	9.46262
to the departure	-	15.67 -	8.19501

For difference of latitude.

As radius	-	-	10.00000
is to the diftance	-	54 -	1.73239
fo is the co-fine of the courfe		16°, 52'	9.98090
to the difference of latitude	-	51.67 -	1.71329

5. Courfe SE*b*S ½ eaft and diftance 74 miles.

For departure.

As radius	-	-	10.00000
is to the diftance	-	74 -	1.86923
fo is the fine of the courfe		39°, 22' -	9.80228
to the departure	-	46.94 -	1.67151

For difference of latitude.

As radius	-	-	10.00000
is to the diftance	-	74 -	1.80923
fo is the co-fine of the courfe		39°, 22'	9.88824
to the difference of latitude		57.21 -	1.75747

Now thefe feveral courfes and diftances, together with the differences of latitude and departures deduced from them, being fet down in their proper columns in the traverfe table, will ftand as follows.

The Traverse Table.

Courfes.	*Diftances.*	*Diff. of Lat.*		*Departure.*	
		N	*S*	*E*	*W*
SE*b*S —	56	——	46.57	31.11	——
SSE —	64	——	59.13	24.5	——
NW*b*W —	48	26.67	——	——	39.91
S*b*W½W —	54	——	51.67	——	15.67
SE*b*S½E —	94	——	57.21	46.94	——
		26.67	214.58	102.55	55.58
			26.67	55.58	
	Diff. of Lat.		187.91	46.97	*Dep.*

From the above table it is plain, fince the fum of the northings is 26.67, and of the fouthings 214.58, the difference between thefe, *viz.* 187.91, will be the fouthing made good by the fhip the laft 24 hours; alfo the fum of the eaftings being 102.55, and of the weftings 55.58, the difference 46.97 will be the eafting or departure made good by the fhip's laft 24 hours; confequently, to find the true courfe and diftance made good by the fhip in that time, it will be (by *Cafe* 4. *of Plane Sailing*,)

PRACTICE.

As the difference of latitude	-	187.91	2.27393
is to the radius	-	-	10.00000
fo is the departure	-	46.97	1.67182
to the tangent of the courfe		14°, 03' -	9.39789

which is S*b*E ¼ eaft nearly. Then for the diftance, it will be,

As radius	-	-	10.00000
is to the difference of latitude	-	187.91	2.27393
fo is the fecant of the courfe	-	14°, 03'	10.01319
to the diftance	-	193.7 -	2.28712

confequently the fhip has made good the laft 24 hours, on a S*b*E ¼ eaft courfe, 193.7 miles: and fince the fhip is failing towards the equator; therefore,

From the latitude failed from	-	48°, 24' N
take the diff. of latitude made good	-	3 , 08 S
there remains	- -	45 , 16 N

the latitude the fhip is in north. And becaufe the port the fhip is bound for lies in the latitude of 43° 40' N. and confequently fouth of the fhip; therefore,

From the latitude the fhip is in	-	45°, 16' N
take the latitude fhe is bound for	-	43 , 40 N
and there remains	- -	1 , 36

or 96 miles, the difference of latitude or fouthing the fhip has to make. Again, the whole eafting the fhip had to make being 144 miles, and fhe having already made 46.97 or 47 miles of eafting; therefore the departure or eafting fhe ftill has to make will be 97 miles: confequently, to find the direct courfe and diftance between the fhip and the intended port, it will be (by *Cafe* 4. *of Plane Sailing*,)

As the difference of latitude	-	96 -	1.98227
is to radius	- -	-	10.00000
fo is the departure	-	97 -	1.98677
to the tangent of the courfe		45°, 19'	10.00450

And

As radius	-	-	10.00000
is to the difference of latitude		96 -	1.98227
fo is the fecant of the courfe		45°, 19'	10.15293
to the diftance	-	136.5 -	2.13620

whence the true bearing and diftance of the intended port is SE, 136.5 miles.

§ 2. *Of Parallel Sailing.*

1. Since the parallels of latitude do always decreafe the nearer they approach the pole, it is plain a degree on any of them muft be lefs than a degree upon the equator. Now in order to know the length of a degree on any of them, let PB (n° 10.) reprefent half the earth's axis, PA a quadrant of a meridian, and confequently A a point on the equator, C a point on the meridian, and CD a perpendicular from that point upon the axis, which plainly will be the fine of CP the diftance of that point from the pole, or the co-fine of CA its diftance from the equator; and CD will be to AB, as the fine of CP, or co-fine of CA, is to the radius. Again, if the quadrant PAB is turned round upon the axis PB, it is plain the point A will defcribe the circumference of the equator whofe radius is AB, Plate CCI.

and

and any other point C upon the meridian will describe the circumference of a parallel whofe radius is CD.

Cor. I. Hence (becaufe the circumference of circles are as their radii) it follows, that the circumference of any parallel is to the circumference of the equator, as the co-fine of its latitude is to radius.

Cor. II. And fince the wholes are as their fimilar parts, it will be, As the length of a degree on any parallel is to the length of a degree upon the equator, fo is the co-fine of the latitude of that parallel to radius.

Cor. III. Hence, as radius is to the co-fine of any latitude, fo are the minutes of difference of longitude between two meridians, or their diftance in miles upon the equator, to the diftance of thefe two meridians on the parallel in miles.

Cor. IV. And as the co-fine of any parallel is to radius, fo is the length of any arch on that parallel (intercepted between two meridians) in miles, to the length of a fimilar arch on the equator, or minutes of difference of longitude.

Cor. V. Alfo, as the co-fine of any one parallel is to the co-fine of any other parallel, fo is the length of any arch on the firft, in miles, to the length of the fame arch on the other in miles.

2. From what has been faid, arifes the folution of the feveral cafes of parallel failing, which are as follow.

Case I. Given the difference of longitude between two places, both lying on the fame parallel; to find the diftance between thofe places.

Example I. Suppofe a fhip in the latitude of 54° 20′ north, fails directly weft on that parallel till fhe has differed her longitude 12° 45′; required the diftance failed on that parallel.

Firft, The difference of longitude reduced into minutes, or nautical miles, is 765′, which is the diftance between the meridian failed from, and the meridian come to, upon the equator; then to find the diftance between thefe meridians on the parallel of 54° 20′, or the diftance failed, it will be, by *Cor.* 3. of the laft article,

As radius	- -	10.00000
is to the co-fine of the lat.	- 54°, 20′ -	9.76572
fo are the minutes of diff. long.	765 -	2.88366
to the diftance on the parallel	446.1 -	2.64938

Example II. A degree on the equator being 60 minutes or nautical miles; required the length of a degree on the parallel of 51° 32′.

By Cor. 3. of the laft article, it will be

As radius	- -	10.00000
is to the co-fine of the latitude	- 51°, 32′	9.79383
fo are the minutes in 1 degree on the equa.	60	1.77815
to - - -	37.32	1.57198

the miles anfwering to a degree on the parallel of 51° 32′

By this problem the following table is conftructed, fhewing the geographic miles anfwering to a degree on any parallel of latitude; in which you may obferve, that the columns marked at the top with *D. L.* contain the degrees of latitude belonging to each parallel; and the adjacent columns marked at the top, *Miles*, contain the geographic miles anfwering to a degree upon thefe parallels.

A Table fhewing how many Miles anfwer to a Degree of Longitude, at every Degree of Latitude.

D. L.	*Miles.*	*D. L.*	*Miles.*	*D. L.*	*Miles.*	*D. L.*	*Miles*	*D. L.*	*Miles.*
1	59.99	19	56.73	37	47.92	55	34.41	73	17.54
2	59.97	20	56.38	38	47.28	56	33.55	74	16.53
3	59.92	21	56 01	39	46.62	57	32.68	75	15.52
4	59.86	22	55.63	40	45.95	58	31.79	76	14.51
5	59.77	23	55.23	41	45.28	59	30.90	77	13.50
6	59.67	24	54.81	42	44.95	60	30.00	78	12.48
7	59.56	25	54.38	43	43.88	61	29.09	79	11.45
8	59.44	26	53.93	44	43.16	62	28.17	80	10.42
9	59.26	27	53.46	45	42.43	63	27.24	81	9.38
10	59.08	28	52.97	46	51.68	64	26.30	82	8.35
11	59.89	29	52.47	47	40.92	65	25.36	83	7.32
12	58.68	30	51.96	48	40 15	66	24.41	84	6.28
13	58.46	31	51.43	49	39.36	67	23.45	85	5.23
14	58.22	32	50.88	50	38.57	68	22.48	86	4.18
15	57.95	33	50.32	51	37.76	69	21.50	87	3.14
16	57.67	34	49.74	52	36 94	70	20.52	88	2.09
17	57.36	35	49.15	53	36.11	71	19.54	89	1.05
18	57.06	36	48.54	54	35.26	72	18.54	90	0.00

Though this table does only fhew the miles anfwering to a degree of any parallel, whofe latitude confifts of a whole number of degrees; yet it may be made to ferve for any parallel whofe latitude is fome number of degrees and minutes, by making the following proportion, *viz.*

As 1 degree, or 60 minutes, is to the difference between the miles anfwering to a degree in the next greater and next lefs tabular latitude than that propofed; fo is the excefs of the propofed latitude above the next tabular latitude, to a proportional part; which, fubtracted from the miles anfwering to a degree of longitude in the next lefs tabular latitude, will give the miles anfwering to a degree in the propofed latitude.

Example. Required to find the miles anfwering to a degree on the parallel of 56° 44′.

Firft, The next lefs parallel of latitude in the table than that propofed, is that of 56°; a degree of which (by the table) is equal to 33.55 miles; and the next greater parallel of latitude in the table, than that propofed, is that of 57°, a degree of which is (by the table) equal to 32.68 miles; the difference of thefe is 87, and the diftance between thefe parallels is 1 degree, or 60 minutes; alfo the diftance between the parallel of 56°, and the propofed parallel of 56° 44′, is 44 minutes: then by the preceding proportion it will be, as 60 is to 87, fo is 44 to 638, the difference between a degree on the parallel of 56° and a degree on the parallel of 56° 44′; which therefore, taken from 33.55, the miles anfwering to a degree on the parallel of 56°, leaves 32.912, the miles anfwering to a degree on the parallel of 56° 44′, as was required.

Case II. The diftance failed in any parallel of latitude, or the diftance between any two places on that parallel, being given; to find the difference of longitude.

Example. Suppofe a fhip in the latitude of 55° 36′ north.

 north ſails directly eaſt 685.6 miles: Required how much ſhe has differed her longitude.

By Cor. 4. Art. 1. of this ſection, it will be

As the co-ſine of the lat.	55° 36′	9.75202
is to radius		10.00000
ſo is the diſtance ſailed	685.6	2.83607
to min. of diff. of long.	1213	3.08405

which reduced into degrees, by dividing by 60, makes 20° 13′, the difference of longitude the ſhip has made.

This alſo may be ſolved by help of the foregoing table, *viz.* by finding from it the miles anſwering to a degree on the propoſed parallel, and dividing with this the given number of miles, the quotient will be the degrees and minutes of difference of longitude required.

Thus in the laſt example, we find, from the foregoing table, that a degree on the parallel of 55° 36′ is equal to 33.89 miles; by this we divide the propoſed number of miles 685.6, and the quotient is 20.13 degrees, *i. e.* 20° 13′, the difference of longitude required.

Case III. The difference of longitude between two places on the ſame parallel, and the diſtance between them, being given; to find the latitude of that parallel.

Example. Suppoſe a ſhip ſails on a certain parallel directly weſt 624 miles, and then has differed her longitude 18° 46′, or 1126 miles: Required the latitude of the parallel ſhe ſailed upon.

By Cor. 3. Art. 1. of this ſection, it will be,

As the min. of diff. long.	1126	3.05154
is to the diſtance ſailed	624	2.79518
ſo is radius		10.00000
to the co-ſine of the lat.	56°, 21′	9.74364

conſequently the latitude of the ſhip or parallel ſhe ſailed upon was 56° 21′.

From what has been ſaid, may be ſolved the following problems.

Prob. I. Suppoſe two ſhips in the latitude of 46° 30′ north, diſtant aſunder 654 miles, ſail both directly north 256 miles, and conſequently are come to the latitude of 50° 46′ north: Required their diſtance on that parallel.

By Cor. 6. Art. 1. of this ſection, it will be,

As the co-ſine of	46°, 30′	9.83781
is to the co-ſine of	50°, 46′	9.80105
ſo is	654	2.81558
to	601	2.77882

the diſtance between the ſhips when on the parallel of 50° 46′.

Prob. II. Suppoſe two ſhips in the latitude of 45° 48′ north, diſtant 846 miles, ſail directly north till the diſtance between them is 624 miles: Required the latitude come to, and the diſtance ſailed.

By Cor. 5. Art. 1. of this ſection, it will be,

As their firſt diſtance	846	2.92737
is to their ſecond diſtance	624	2.79518
ſo is the co-ſine of	45°, 48′	9.84334
to the coſine	59, 04	9.71115

the latitude of the parallel the ſhips are come to.

Conſequently to find their diſtance ſailed,

From the latitude come to	59°, 04′
ſubtract the latitude ſailed from	45, 48
and there remains	13, 16

equal to 796 miles, the difference of latitude or diſtance ſailed.

§ 3. *Of Middle-latitude Sailing.*

1. When two places lie both on the ſame parallel, we ſhewed in the laſt ſection, how, from the difference of longitude given, to find the miles of eaſting or weſting between them, *et è contra*. But when two places lie not on the ſame parallel, then their difference of longitude cannot be reduced to miles of eaſting or weſting on the parallel of either place: for if counted on the parallel of that place that has the greateſt latitude, it would be too ſmall; and if on the parallel of that place having the leaſt latitude, it would be too great. Hence the common way of reducing the difference of longitude between two places, lying on different parallels, to miles of eaſting or weſting, *et è contra*, is by counting it on the middle parallel between the places, which is found by adding the latitudes of the two places together, and taking half the ſum, which will be the latitude of the middle parallel required. And hence ariſes the ſolution of the following caſes.

Case I. The latitudes of two places, and their difference of longitude, given; to find the direct courſe and diſtance.

Example. Required the direct courſe and diſtance between the Lizard in the latitude of 50° 00′ north, and longitude of 5° 14′ weſt, and St Vincent in the latitude of 17° 10′ N. and longitude of 24 20 W.

Firſt, To the latitude of the Lizard	50°, 00′ N.
add the latitude of St Vincent	17, 10
The ſum is	67, 10
Half the ſum or latitude of the middle parallel is	33, 35 N.
Alſo the difference of latitude is	33, 50

equal to 1970 miles of ſouthing. Again,

From the longitude of St Vincent	24, 20 W.
take the longitude of the Lizard	05, 14
there remains	16, 06

equal to 1146 min. of diff. of long. weſt.

Then for the miles of weſting, or departure, it will be, (by *Caſe* 1. *of Parallel Sailing*)

As radius		10.00000
is to the co-ſine of the middle parallel	33°, 35′	9.92069
ſo is min. diff. of long.	1146	3.05918
to the miles of weſting	954.7	2.97987

And for the courſe it will be, (by *Caſe* 4. *of Plane Sailing*)

As the diff. of lat.	1970	3.29447
is to radius		10.00000
ſo is the departure	954.7	2.97987
to the tang. of the courſe	25°, 51′	9.68540

which, becauſe it is between ſouth and weſt, it will be SSW $\frac{1}{4}$ weſt nearly.

For the diſtance, it will be, by the ſame caſe,

As radius		10.00000
is to the diff. of lat.	1970	3.29447
ſo is the ſecant of the courſe	25°, 51′	10.04579
to the diſtance	2189	3.34026

whence the direct courſe and diſtance from the Lizard to St Vincent is SSW $\frac{1}{4}$ 2189 W miles.

Case II. One latitude, courſe, and diſtance ſailed being

PRACTICE

being given; to find the other latitude and difference of longitude.

Example. Suppoſe a ſhip in the latitude of 50° 00' north, ſails ſouth 50°06' weſt, 150 miles: Required the latitude the ſhip has come to, and how much ſhe has differed her longitude.

Firſt, For the difference of latitude, it will be, (by *Caſe* 1. *of Plane Sailing*,)

As radius		10.00000
is to the diſtance	150	2.17609
ſo is the co-ſine of the courſe 50°, 06'		9.80716
to the diff. of latitude	96.22	1.98325

equal to 1°, 36'. And ſince the ſhip is ſailing towards the equator; therefore,

From the latitude ſhe was in	50°, 00'
take the diff. of latitude	1, 36
and there remains	48, 24

the latitude ſhe has come to north. Conſequently the latitude of the middle parallel will be 49° 12'.

Then for departure or weſting it will be, by the ſame *Caſe*,

As radius		10.00000
is to the diſtance	150	2.17609
ſo is the ſine of the courſe 50°, 06'		9.88489
to the departure	115.1	2.06098

As for the difference of longitude, it will be, (by *Caſe* 2. *of Plane Sailing*,)

As the co-ſine of the middle parallel 49° 12'		9.81519
is to radius		10.00000
ſo is the departure	115.1	2.06098
to the min. diff. of longitude	176.1	2.24579

equal to 2° 56', which is the difference of longitude the ſhip has made weſterly.

Case III. Courſe and difference of latitude given; to find the diſtance ſailed, and difference of longitude.

Example. Suppoſe a ſhip in the latitude of 53° 34' north, ſails SE*b*S, till by obſervation ſhe is found to be in the latitude of 51° 12', and conſequently has differed her latitude 2° 22', or 142 miles: Required the diſtance ſailed, and the difference of longitude.

Firſt, for the departure, it will be, (by *Caſe* 2. *of Plane Sailing*,)

As radius		10.00000
is to the diff. of latitude	142	2.15229
ſo is the tang. of courſe 33°, 45'		9.82489
to the departure	94.88	1.97718

And for the diſtance it will be, (by the ſame *Caſe*,)

As radius		10.00000
is to the diff. of latitude	142	2.15229
ſo is the ſecant of the courſe 33°, 45'		10.08015
to the diſtance	170.8	2.23244

Then, ſince the latitude ſailed from was 53° 34' north, and the latitude come to 51° 12' north; therefore the middle parallel will be 52° 23'; and conſequently, for the difference of longitude, it will be (by *Caſe* 2. *of Parallel Sailing*.)

As the co-ſine of the mid. parallel 52°, 23'		9.78560
is to the departure	94.88	1.97718
ſo is radius		10.00000
to min. of diff. of longitude	155.5	2.19158

equal to 2o 35' the difference of longitude eaſterly.

Case IV. Difference of latitude and diſtance ſailed, given; to find the courſe and difference of longitude.

Example. Suppoſe a ſhip in the latitude of 43° 26' north, ſails between ſouth and eaſt, 246 miles, and then is found by obſervation to be in the latitude of 41° 06' north: Required the direct courſe and difference of longitude.

Firſt, For the courſe, it will be, (by *Caſe* 3. *of Plane Sailing*,)

As the diſtance	246	2.39094
is to radius		10.00000
ſo is the diff. of latitude	140	2.14613
to the co-ſine of the courſe 55°, 19'		9.75519

which, becauſe the ſhip ſails between ſouth and eaſt, will be ſouth 55° 19' eaſt, or SE*b*E nearly.

Then for departure, it will be, by the ſame *Caſe*,

As radius		10.00000
is to the diſtance	246	2.39094
ſo is the ſine of the courſe 55°, 19'		9.91504
to the departure	202.3	2.30598

Laſtly, For the difference of longitude, it will be, (by *Caſe* 2. *of Parallel Sailing*,)

As the co-ſine of the mid. par. 42°, 16		9.86924
is to the departure	302.3	2.30598
ſo is radius		10.00000
to min. of diff. of longitude	273.3	2.43674

equal to 4° 33', the difference of longitude eaſterly.

Case V. Courſe and departure given, to find difference of latitude, difference of longitude, and diſtance ſailed.

Example. Suppoſe a ſhip in the latitude of 48° 23' north, ſails SW*b*S, till ſhe has made of weſting 123 miles: Required the latitude come to, the difference of longitude, and the diſtance ſailed.

Firſt, For the diſtance, it will be, (by *Caſe* 6. *of Plane Sailing*,)

As the ſine of the courſe 33°, 45'		6.74474
is to the departure	123	2.08991
ſo is radius		10.00000
to the diſtance	221.4	2.34517

And for the difference of latitude, it will be, by the ſame *Caſe*,

As the tang. of courſe 33°, 45'		9.82489
is to the departure	123	2.08991
ſo is radius		10.00000
to the diff. of latitude	184	2.26502

equal to 3° 04': And ſince the ſhip is ſailing towards the equator, the latitude come to will be 45° 19' north; and conſequently the middle parallel will be 46° 51'.

Then to find the difference of longitude, it will be, (*Caſe* 2. *of Parallel Sailing*,)

As the co-ſine of mid. par. 46°, 51'		9.83500
is to departure	123	2.08991
ſo is radius		10.00000
to min. of diff. of longit.	180	2.25491

which is equal to 3° 00', the difference of longitude weſterly.

Case VI. Difference of latitude and departure given, to find courſe, diſtance, and difference of longitude.

Example. Suppoſe a ſhip in the latitude of 46° 37' north, ſails between ſouth and eaſt, till ſhe has made of eaſting 146 miles, and is then found by obſervation to be in the latitude of 43° 24' north: Re-

Required the courſe, diſtance, and difference of longitude.

Firſt, By *Caſe* 4. *of Plane Sailing*, it will be for the courſe,

As the diff. of latitude	193	2.28556
is to departure	146	2.16137
ſo is radius		10.00000
to the tang. of the courſe	36°, 55'	9.87581

which, becauſe the ſhip is ſailing between ſouth and eaſt, will be ſouth 36° 55' eaſt, or SE*b*S ¼ eaſt nearly.

For the diſtance, it will be, by the ſame *Caſe*,

As radius		10.00000
is to the diff. of latitude	193	2.28556
ſo is the ſecant of the courſe	36°, 55'	10.09718
to the diſtance	241.4	2.38274

Then for the difference of longitude, it will be, by *Caſe* 2. *of Parallel Sailing*,

As the co-ſine of the mid. par.	45°, 00'	9.84949
is to the departure	146	2.16137
ſo is radius		10.00000
to min. of diff. of longitude	205	2.31188

equal to 3° 25', the difference of longitude eaſterly.

Case VII. Diſtance and departure given, to find difference of latitude, courſe, and difference of longitude.

Example. Suppoſe a ſhip in the latitude of 33° 40' north, ſails between ſouth and eaſt 165 miles, and has then made of eaſting 112.5 miles: Required the difference of latitude, courſe, and difference of longitude.

Firſt, for the courſe, it will be, by *Caſe* 5. *of Plane ſailing*,

As the diſtance	165	2.21748
is to radius		10.00000
ſo is the departure	102.5	2.05115
to the ſine of the courſe	42°, 59'	9.83367

which, becauſe the ſhip ſails between ſouth and eaſt, will be ſouth 42° 59' eaſt, or SE*b*E ½ eaſt nearly.

And for the difference of latitude, it will be, by the ſame *Caſe*,

As radius		10.00000
is to the diſtance	165	2.21748
ſo is the co-ſine of the courſe	42,° 59'	9.86436
to the difference of lat.	120.7	2.08184

equal to 2° 00'; conſequently the latitude come to will be 31° 40' north, and the latitude of the middle parallel will be 32° 40'. Hence, to find the difference of longitude, it will be, by *Caſe* 2. *of Parallel Sailing*,

As the co-ſine of the mid. par.	32°, 40'	9.92522
is to the departure	112.5	2.05115
ſo is radius		10.00000
to min. of diff. of long.	133.6	2.12593

equal to 2° 13' nearly, the difference of longitude eaſterly.

Case VIII. Difference of longitude and departure given; to find difference of latitude, courſe, and diſtance ſailed.

Example. Suppoſe a ſhip in the latitude of 50° 46' north, ſails between ſouth and weſt, till her difference of longitude is 3° 12', and is then found to have departed from her former meridian 126 miles; required the difference of latitude, courſe, and diſtance ſailed.

Firſt, For the latitude ſhe has come to, it will be, by *Caſe* 3. *of Parallel Sailing*,

As min. of diff. of long.	192	2.28330
is to departure	126	2.10037
ſo is radius		10.00000
to the co-ſine of the mid. par.	48°, 59'	9.81707

Now ſince the middle latitude is equal to half the ſum of the two latitudes (by art. 1. of this ſect.) and ſo the ſum of the two latitudes equal to double the middle latitude; it follows, that if from double the middle latitude we ſubtract any one of the latitudes, the remainder will be the other. Hence from twice 48° 59', *viz.* 97° 58', taking 50° 46' the latitude ſailed from, there remains 47° 12' the latitude come to; conſequently the difference of latitude is 3° 34', or 214 minutes.

Then for the courſe, it will be, by *Caſe* 4. *of Plane Sailing*,

As diff. of lat.	214	2.33041
is to radius		10.00000
ſo is the departure	126	2.10037
to the tang. of the courſe	30°, 29'	9.76996

which, becauſe it is between ſouth and weſt, will be ſouth 30° 29' weſt, or SSW ½ weſt nearly.

And for the diſtance, it will be, by the ſame *Caſe*,

As radius		10.00000
is to the diff. of lat.	214	2.33041
ſo is the ſecant of the courſe	30°, 29'	10.06461
to the diſtance	248.4	2.39502

2. From what has been ſaid, it will be eaſy to ſolve a traverſe, by the rules of *Middle-latitude Sailing*.

Example. Suppoſe a ſhip in the latitude of 43° 25' north, ſails upon the following courſes, *viz.* SW*b*S 63 miles, SSW ½ weſt 45 miles, S*b*E 54 miles, and SW*b*W 74 miles: Required the latitude the ſhip has come to, and how far ſhe has differed her longitude.

Firſt, By *Caſe* 2. *of this Sect.* find the difference of latitude and difference of longitude belonging to each courſe and diſtance, and they will ſtand as in the following table.

Courſes.	*Diſtances.*	*Diff. of Lat.*		*Diff. of Longit.*	
		N	*S*	*E*	*W*
SW*b*S	— 63	——	52.4	——	47.85
SSW½W	— 45	——	39.7	——	28.62
S*b*E	— 54	——	53.0	14.75	——
SW*b*W	— 74	——	41.1	——	81.08
			——		157.55
		Diff. of Lat.	186.2		13.75
				Diff. of Long.	143.80

Hence it is plain the ſhip has differed her latitude 186.2 minutes, or 3° 6', and ſo has come to the latitude of 40° 19' north, and has made of difference of longitude 143.8 minutes, or 2° 23' 48" weſterly.

3. This method of ſailing, though it be not ſtrictly true, yet it comes very near the truth, as will be evident, by comparing an example wrought by this method with the ſame wrought by the method delivered

PRACTICE vered in the next section, which is strictly true; and it serves, without any considerable error, in runnings of 450 miles between the equator and parallel of 30 degrees, of 300 miles between that and the parallel of 60 degrees, and of 150 miles as far as there is any occasion, and consequently must be sufficiently exact for 24 hours run.

§. 4. *Of Mercator's sailing.*

1. THOUGH the meridians do all meet at the pole, and the parallels to the equator do continually decrease, and that in proportion to the co-sines of their latitudes; yet in old sea-charts the meridians were drawn parallel to one another, and consequently the parallels of latitude made equal to the equator, and so a degree of longitude on any parallel as large as a degree on the equator: also in these charts the degrees of latitude were still represented (as they are in themselves) equal to each other, and to those of the equator. By these means the degrees of longitude being increased beyond their just proportion, and the more so the nearer they approach the pole, the degrees of latitude at the same time remaining the same, it is evident places must be very erroneously marked down upon these charts with respect to their latitude and longitude, and consequently their bearing from one another very false.

2. To remedy this inconvenience, so as still to keep the meridians parallel, is is plain we must protract, or lengthen, the degrees of latitude in the same proportion as those of longitude are, that so the proportion in easting and westing may be the same with that of southing and northing, and consequently the bearings of places from one another be the same upon the chart as upon the globe itself.

Plate CCIV. Let ABD (N° 11.) be a quadrant of a meridian, A the pole, D a point on the equator, AC half the axis, B any point upon the meridian, from which draw BF perpendicular to AC, and BG perpendicular to CD; then BG will be the sine, and BF or CG the co-sine of BD the latitude of the point B; draw D the tangent and CE the secant of the arch CD. It has been demonstrated in Sect. 2. that any arch of a parallel is to the like arch of the equator as the co-sine of the latitude of that parallel is to radius. Thus any arch as a minute on the parallel described by the point B, will be to a minute on the equator as BF or CG is to CD; but since the triangles CGB CDE are similar, therefore CG will be to CD as CB is to CE, *i. e.* the co-sine of any parallel is to radius as radius is to the secant of the latitude of that parallel. But it has been just now shown, that the co-sine of any parallel is to radius, as the length of any arch as a minute on that parallel is to the length of the like arch on the equator: therefore the length of any arch as a minute on any parallel, is to the length of the like arch on the equator, as radius is to the secant of the latitude of that parallel; and so the length of any arch, as a minute on the equator, is longer than the like arch of any parallel in the same proportion as the secant of the latitude of that parallel is to radius. But since in this projection the meridians are parallel, and consequently each parallel of latitude equal to the equator, it is plain the length of any arch as a minute on any parallel, is increased beyond its just proportion, at such rate as the secant of the latitude of that parallel is greater than radius; and therefore, to keep up the proportion of northing and southing to that of easting and westing, upon this chart, as it is upon the globe itself, the length of a minute upon the meridian at any parallel must also be increased beyond its just proportion at the same rate, *i. e.* as the secant of the latitude of that parallel is greater than radius. Thus to find the length of a minute upon the meridian at the latitude of 75 degrees, since a minute of a meridian is every-where equal on the globe, and also equal to a minute upon the equator, let it be represented by unity; then making it as radius is to the secant of 75 degrees, so is unity to a fourth number, which is 3.864 nearly; and consequently, by whatever line you represent one minute on the equator of this chart, the length of one minute on the enlarged meridian at the latitude of 75 degrees, or the distance between the parallel of 75° 00′ and the parallel of 75° 01′, will be equal to 3 of these lines, and $\frac{864}{1000}$ of one of them. By making the same proportion, it will be found, that the length of a minute on the meridian of this chart at the parallel of 60°, or the distance between the parallel of 60° 00′ and that of 60° 01′, is equal to two of these lines. After the same manner, the length of a minute on the enlarged meridian may be found at any latitude; and consequently, beginning at the equator, and computing the length of every intermediate minute between that and any parallel, the sum of all these shall be the length of a meridian intercepted between the equator and that parallel; and the distance of each degree and minute of latitude from the equator upon the meridian of this chart, computed in minutes of the equator, forms what is commonly called a *table of meridional parts*.

If the arch BD (N° 11.) represent the latitude of any point B, then (CD being radius) CE will be the secant of that latitude: but it has been shown above, that radius is to secant of any latitude, as the length of a minute upon the equator is to the length of a minute on the meridian of this chart at that latitude; therefore CD is to CE, as the length of a minute on the equator is to the length of a minute upon the meridian, at the latitude of the point B. Consequently, if the radius CD be taken equal to the length of a minute upon the equator, CE, or the secant of the latitude, will be equal to the length of a minute upon the meridian at that latitude. Therefore, in general, if the length of a minute upon the equator be made radius, the length of a minute upon the enlarged meridian will be every-where equal to the secant of the arch contained between it and the equator.

COR. 1. Hence it follows, since the length of every intermediate minute between the equator and any parallel, is equal to the secant of the latitude, (the radius being equal to a minute upon the equator), the sum of all these lengths, or the distance of that parallel on the enlarged meridian from the equator, will be equal to the sum of all the secants, to every minute contained between it and the equator.

COR. 2. Consequently the distance between any two parallels on the same side of the equator is equal to the difference of the sums of all the secants contained be-

tween the equator and each parallel, and the diftance between any two parallels on contrary fides of the equator is equal to the fum of the fums of all the fecants contained between the equator and each parallel.

3. By the tables of meridional parts given by all the writers on this fubject, may be conftructed the nautical chart, commonly called *Mercator's chart*. Thus, for example, let it be required to make a chart that fhall commence at the equator, and reach to the parallel of 60 degrees, and fhall contain 80 degrees of longitude.

Draw the line EQ reprefenting the equator, (fee N° 12.): then take, from any convenient line of equal parts, 4800, (the number of minutes containing in 80 degrees), which fet off from E to Q, and this will determine the breadth of the chart.

Divide the line EQ into eight equal parts, in the points 10, 20, 30, &c, each containing 10 degrees; and each of thefe divided into 10 equal parts, will give the fingle degrees upon the equator: then through the points E, 10, 12, &c. drawing lines perpendicular to EQ, thefe fhall be meridians.

From the fcale of equal parts take 4527.4, (the meridional parts anfwering to 60 degrees), and fet that off from E to A and from Q to B, and join AB; then this line will reprefent the parallel of 60, and will determine the length of the chart.

Again, from the fcale of equal parts take 603.1, (the meridional parts anfwering to 10 degrees), and fet that off from E to 10 on the line EA; and through the point 10 draw 10, 10, parallel to EQ; and this will be the parallel of 10 degrees. The fame way, fetting off from E on the line EA, the meridional parts anfwering to each degree, &c. of latitude, and through the feveral points drawing lines parallel to EQ, we fhall have the feveral parallels of latitude.

If the chart does not commence from the equator, but is only to ferve for a certain diftance on the meridian between two given parallels on the fame fide of the equator; then the meridians are to be drawn as in the laft example: and for the parallels of latitude you are to proceed thus, viz. From the meridional parts anfwering to each point of latitude in your chart fubtract the meridional parts anfwering to the leaft latitude, and fet off the differences feverally, from the parallel of the leaft latitude, upon the two extreme meridians; and the lines joining thefe points of the meridians fhall reprefent the feveral parallels upon your chart.

Thus let it be required to draw a chart that fhall ferve from the latitude of 20 degrees north to 60 degrees north, and that fhall contain 80 degrees of longitude.

Having drawn the line DC to reprefent the parallel of 20 degrees (fee N° 12.) and the meridians to it, as in the foregoing example; fet off 663.3 (the difference between the meridional parts anfwering to 30 degrees, and thofe of 20 degrees) from D to 30, and from C to 30; then join the points 30 and 30 with a right line, and that fhall be the parallel of 30. Alfo fet off 1397.6 (the difference between the meridional parts anfwering to 40 degrees, and thofe of 20 degrees) from D to 40, and from C to 40; and joining the points 40 and 40 with a right line, that fhall be the parallel of 40. And proceeding after the fame way, we may draw as many of the intermediate parallels as we have occafion for.

But if the two parallels of latitude that bound the chart, are on the contrary fides of the equator; then draw a line reprefenting the equator and meridians to it, as in the firft example; and from the equator fet off on each fide of it the feveral parallels contained between it and the given parallels as above, and your chart is finifhed.

If Mercator's chart, conftructed as above, hath its equator extended on each fide of the point E 180 degrees, and if the feveral places on the furface of the earth be there laid down according to their latitudes and longitudes, we fhall have what is commonly called *Mercator's map of the earth*. This map is not to be confidered as a fimilar and juft reprefentation of the earth's furface; for in it the figures of countries are diftorted, efpecially near the poles: but fince the degrees of latitude are every where increafed in the fame proportion as thofe of longitude are, the bearings between the places will be the fame in this chart as on the globe; and the proportions between the latitudes, longitudes, and nautical diftances, will alfo be the fame on this chart, as on the globe itfelf; by which means the feveral cafes of navigation are folved after a moft eafy manner, and adapted to the meaneft capacities.

N. B. Here you muft take notice, that in all charts the upper part is the north fide, and the lower part or bottom is the fouth fide; alfo that part of it towards the right-hand is the eaft, and that towards the left-hand the weft fide of the chart.

4. Since, according to this projection, the meridians are parallel right lines; it is plain, that the rhumbs which form always equal angles with the meridians, will be ftraight lines; which property renders this projection of the earth's furface much more eafy and proper for the ufe than any other.

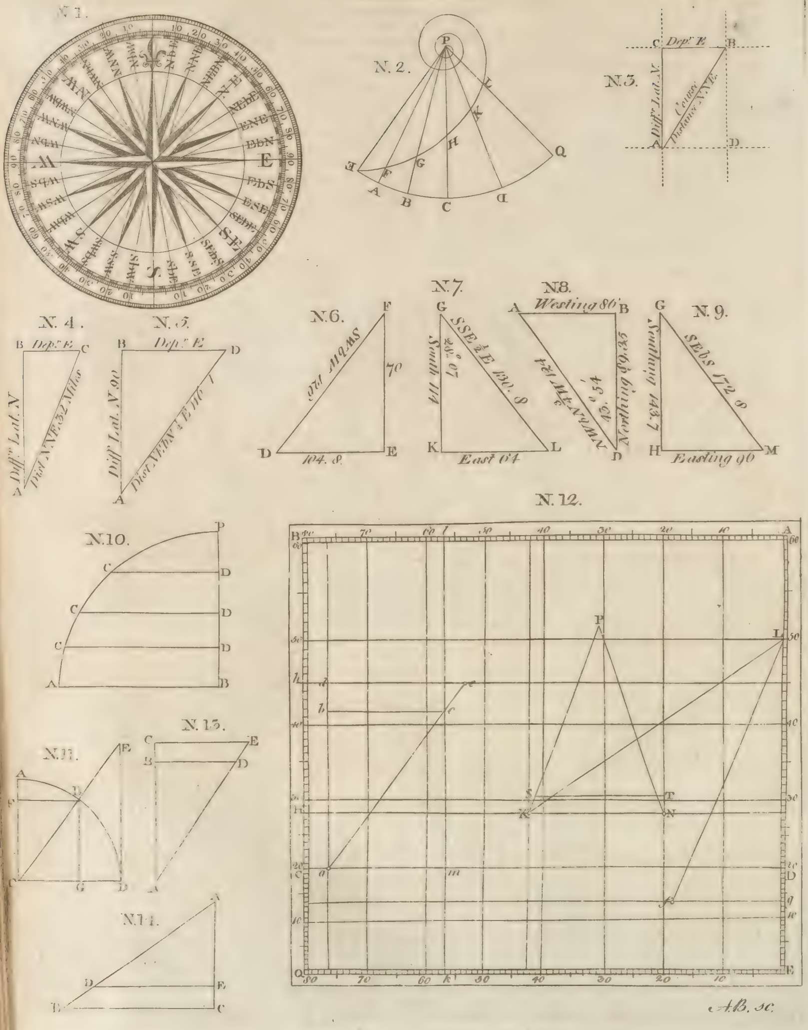
5. This method of projecting the earth's furface upon a plane, was firft invented by Mr Edward Wright, but firft publifhed by Mercator; and hence the failing by the chart was called *Mercator's failing*.

6. In N° 13. let A and E reprefent two places upon Mercator's chart, AC the meridian of A, and CE the parallel of latitude paffing through E; draw AE, and fet off upon AC the length AB equal to the number of minutes contained in the difference of latitude between the two places, and taken from the fame fcale of equal parts the chart was made by, or from the equator, or any graduated parallel of the chart, and through B draw BD parallel to CE meeting AE in D. Then AC will be the enlarged difference of latitude, AB the proper difference of latitude, CE the difference of longitude, BD the departure, AE the enlarged diftance, and AD the proper diftance, between the two places A and E; alfo the angle BAD will be the courfe, and AE the rhumb-line between them.

7. Now fince in the triangle ACE, BD is parallel to one of its fides CE; it is plain the triangles ACE, ABD, will be fimilar, and confequently the fides proportional. Hence arife the folutions of the feveral cafes in this failing, which are as follow.

Case I. The latitudes of two places given, to find the meridional or enlarged difference of latitude between

NAVIGATION. Plate CCII.



A.B. sc.

PRACTICE tween them.

Of this cafe there are three varieties, *viz.* either one of the places lies on the equator, or both on the fame fide of it; or laftly, on different fides.

1. If one of the propofed places lies on the equator, then the meridional difference of latitude is the fame with the latitude of the other place, taken from the table of meridional parts.

EXAMPLE. Required the meridional difference of latitude between St Thomas, lying on the equator, and St Antonio in the latitude of 17° 20′ north. We look in the tables for the meridional parts anfwering to 17° 20′, and find it to be 1056.2, the enlarged difference of latitude required.

2. If the two propofed places be on the fame fide of the equator, then the meridional difference of latitude is found by fubtracting the meridional parts anfwering to the leaft latitude from thofe anfwering to the greateft, and the difference is that required.

EXAMPLE. Required the meridional difference of latitude between the Lizard in the latitude of 50° 00′ north, and Antigua in the latitude of 17° 30′ north.

From the meridional parts of	-	50°, 00′	3474.5
fubtract the meridional parts of		17 , 30	1066.7
there remains	-	-	2407.8

the meridional difference of latitude required.

3. If the places lie on different fides of the equator, then the meridional difference of latitude is found by adding together the meridional parts anfwering to each latitude, and the fum is that required.

EXAMPLE. Required the meridional difference of latitude between Antigua in the latitude of 17° 30′ north, and Lima in Peru in the latitude of 12° 30′ fouth.

To the merid. parts anfwering to		17°, 30′	1066.7
add thefe anfwering to	-	12 , 30	756.1
the fum is	-	-	1822.8

the meridional difference of latitude required.

CASE II. The latitudes and longitudes of two places given, to find the direct courfe and diftance between them.

EXAMPLE. Required to find the direct courfe and diftance between the Lizard in the latitude of 50° 00′ north, and Port-Royal in Jamaica in the latitude of 17° 40′; differing in longitude 70° 46′, Port-Royal lying fo far to the weftward of the Lizard.

PREPARATION.

From the latitude of the Lizard	-	50°, 00′	
fubtract the latitude of Port-Royal	-	17 , 40	
and there remains	-	32 , 20	

equal to 1940 minutes, the proper difference of latitude.

Then from the meridional parts of		50°, 00′	3474.5
fubtract thofe of	-	17 , 40	1077.2
and there remains	-	-	2397.3

the meridional or enlarged difference of longitude.

GEOMETRICALLY. Draw the line AC (N° 14.) reprefenting the meridian of the Lizard at A, and fet off from A, upon that line, AE equal to 1940 (from any fcale of equal parts) the proper difference of latitude, alfo AC equal to 2397.3 (from the fame fcale) the meridional or enlarged difference of latitude. Upon the point C raife CB perpendicular to AC, and make CB equal to 4246, the minutes of difference of longitude. PRACTICE

Join AB, and through E draw ED parallel to BC: fo the cafe is conftructed; and AD applied to the fame fcale of equal parts the other legs were taken from, will give the direct diftance, and the angle DAE meafured by the line of chords will give the courfe.

By CALCULATION.

For the angle of the courfe EAD, it will be, (by rectangular trigonometry,)

AC : CB :: R : T, BAC, *i. e.*

As the meridional diff. of lat.	2397.3	-	3.37970
is to the difference of long.	4246.0	-	3.62798
fo is radius	-	-	10.00000
to the tang.of the direct courfe	60° 33′		10.34828

which, becaufe Port-Royal is fouthward of the Lizard, and the difference of longitude wefterly, will be fouth 60° 33′ weft, or SW*b*W ¼ weft nearly.

Then for the diftance AD, it will be, (by rectangular trigonometry),

R : AE :: Sec. A : AD, *i. e.*

As the radius	-	-	10.00000
is the proper diff. of lat.	-	1940 -	3.28780
fo is the fecant of the courfe	-	60°, 33′	10.30833
to the diftance	-	3945.6	3.59613

confequently the direct courfe and diftance between the Lizard and Port-Royal in Jamaica, is fouth 60° 33′, 3945.6 miles.

CASE III. Courfe and diftance failed given, to find difference of latitude and difference of longitude.

EXAMPLE. Suppofe a fhip from the Lizard in the latitude of 50° 00′ north, fails fouth 35° 40′ weft 156 miles: Required the latitude come to, and how much fhe has altered her longitude.

GEOMETRICALLY. 1. Draw the line BK (n° 15;) Plate CCIII reprefenting the meridian of the Lizard at B; from B draw the line BM, making with BK an angle equal to 35° 40′, and upon this line fet off BM equal to 156 the given diftance, and from M let fall the perpendicular MK upon BK.

Then for BK the proper difference of latitude, it will be, (by rectangular trigonometry,)

R : MB :: S, BMK : BK,

i. e. As radius	-	-	10.00000
is to the diftance	-	156 -	2.19312
fo is the co-fine of the courfe		35°, 40′ -	9.90978
to the proper difference of lat.		127 -	2.10290

equal to 2° 07′; and fince the fhip is failing from a north latitude towards the fouth, therefore the latitude come to will be 47° 53′ north. Hence the meridional difference of latitude will be 193.4.

2. Produce BK to D, till BD be equal to 193.4; through D draw DL parallel to MK, meeting DM produced in L; then DL will be the difference of longitude: to find which by calculation, it will be, (by rectangular trigonometry,)

R : BD :: T, LBD : DL,

i. e. As radius	-	-	10.00000
is to the meridional diff. of lat.		193.4 -	2.28646
fo is the tangent of the courfe		35°, 40′	9.85594
to minutes of diff. of long.	-	138.8 -	2.14240

equal to 2° 18′ 48″, the difference of longitude the fhip has made wefterly.

CASE IV. Given courfe and both latitudes, *viz.* the la-

PRACTICE latitude ſailed from, and the latitude come to; to find the diſtance ſailed, and the difference of longitude.

EXAMPLE. Suppoſe a ſhip in the latitude of 50° 20' north, ſails ſouth 33° 45' eaſt, until by obſervation ſhe is found to be in the latitude of 51° 45' north: Required the diſtance ſailed, and the difference of longitude.

GEOMETRICALLY. Draw AB (N° 16.) to repreſent the meridian of the ſhip in the firſt latitude, and ſet off from A to B 155 the minutes of the proper difference of latitude, alſo AG equal to 257.9 the minutes of the enlarged difference of latitude. Through B and G, draw the lines BC and GK perpendicular to AG; alſo draw AK, making with AG an angle of 33° 45', which will meet the two former lines in the points C and K; ſo the caſe is conſtructed, and AC and GK may be found from the line of equal parts: To find which,

By CALCULATION;

Firſt, For the difference of longitude, it will be, (by rectangular trigonometry,)

R : AG :: T, GAK : GK,

i. e. As radius	- -	10.00000
is to the enlarged diff. of lat.	257.9 -	2.41145
ſo is the tang. of the courſe	33°, 45' -	9.82489
to min. of diff. of longitude	172.3 -	2.23634

equal to 2° 52' 18", the difference of longitude the ſhip has made eaſterly.

This might alſo have been found, by firſt finding the departure BC, (by *Caſe* 2. *of Plane Sailing*), and then it would be

AB : BC :: AG : GK, the difference of longitude required.

Then for the direct diſtance AC, it will be, (by rectangular trigonometry,)

R : AB :: Sec. A : AC,

i. e. As radius	- -	10.00000
is to the proper diff. of lat.	- 155 -	2.19033
ſo is the ſecant of the courſe	33°, 45'	10.08015
to the direct diſtance	- 186.4 -	2.27048

conſequently the ſhip has ſailed ſouth 33° 45' eaſt 186.4 miles, and has differed her longitude 2° 52' 18" eaſterly.

CASE V. both latitudes, and diſtance ſailed, given; to find the direct courſe, and difference of longitude.

EXAMPLE. Suppoſe a ſhip from the latitude of 45° 26' north, ſails between north and eaſt 195 miles, and then by obſervation ſhe is found to be in the latitude of 48° 6' north: Required the direct courſe and difference of longitude.

GEOMETRICALLY. Draw AB (n° 17.) equal to 160 the proper difference of latitude, and from the point B raiſe the perpendicular BD; then take 195 in your compaſſes, and ſetting one foot of them in A, with the other croſs the line BD in D. Produce AB, till AC be equal to 233.6 the enlarged difference of latitude. Through C draw CK parallel to BD, meeting AD produced in K: ſo the caſe is conſtructed; and the angle A may be meaſured by the line of chords, and CK by the line of equal parts: To find which,

By CALCULATION:

Firſt, For the angle of the courſe BAD, it will be (by rectangular trigonometry,)

AB : R :: AD : Sec. A. *i. e.*

As the proper diff. of lat.	- 160 -	2.20412
is to radius	- -	10.00000
ſo is the diſtance	- 195 -	2.29003
to the ſecant of the courſe	- 34°, 52'	10.08591

which, becauſe the ſhip is ſailing between north and eaſt, will be north 34° 52' eaſt, or NE*b*N 1° 7' eaſterly.

Then for the difference of longitude, it will be, (by rectangular trigonometry,)

R : AC :: T, A : CK.

i. e. As radius	- -	10.00000
is to the merid. diff. of lat.	- 233.6 -	2.36847
ſo is the tang. of the courſe	34°, 52'	9.84307
to min. of diff. of longitude	162.8 -	2.21154

equal to 2° 42' 48", the difference of longitude eaſterly.

CASE VI. One latitude, courſe, and difference of longitude, given; to find the other latitude, and diſtance ſailed.

EXAMPLE. Suppoſe a ſhip from the latitude of 48° 50' north, ſails ſouth 34° 40' weſt, till her difference of longitude is 2° 42': Required the latitude come to, and the diſtance ſailed.

GEOMETRICALLY. 1. Draw AE (n° 18.) to repreſent the meridian of the ſhip in the firſt latitude, and make the angle EAC equal to 34° 40', the angle of the courſe; then draw FC parallel to AE, at the diſtance of 164 the minutes of difference of longitude, which will meet AC in the point C. From C let fall upon AE the perpendicular CE; then AE will be the enlarged difference of latitude. To find which by calculation, it will be, (by rectangular trigonometry,)

T, A : R :: CE : AE,

i. e. As the tang. of the courſe	34°, 40'	9.83984
is to the radius	- -	10.00000
ſo is min. of diff. longitude	- 164 -	2.21484
to the enlarged diff. of latitude	237.2 -	2.37500

and becauſe the ſhip is ſailing from a north latitude ſoutherly, therefore

From the merid. parts of the latitude ſailed from	- 48°, 50'	3366.9
take the merid. difference of latitude	-	237.2
and there remains	- -	3129.7

the meridional parts of the latitude come to, *viz.* 46° 09'.

Hence for the proper difference of latitude,

From the latitude ſailed from	-	48°, 50' N
take the latitude come to	- -	46 , 09 N
and there remains	- -	2 , 41

equal to 161, the minutes of difference of latitude.

2. Set off upon AE the length AD equal to 161 the proper difference of latitude, and thro' D draw DB parallel to CE: then AB will be the direct diſtance. To find which by calculation, it will be, (by rectangular trigonometry,)

R : AD :: Sec. A : AB.

i. e. As radius	- -	10.00000
is to the proper diff of latitude	- 161	2.20683
ſo is the ſecant of the courſe	- 34°, 40'	10.08488
to the direct diſtance	- 195.8 -	2.29171

CASE VII. One latitude, courſe, and departure given; to find the other latitude, diſtance ſailed, and difference of longitude.

EXAMPLE. Suppoſe a ſhip ſails from the latitude of 54°

54° 36' north, south 42° 33' east, until she has made of departure 116 miles: Required the latitude she is in, her direct distance sailed, and how much she has altered her longitude.

Geometrically. 1. Having drawn the meridian AB, (n° 19.) make the angle BAD equal to 42° 33'. Draw FD parallel to AB at the distance of 116, which will meet AD in D. Let fall upon AB the perpendicular DB. Then AB will be the proper difference of latitude, and AD the direct distance: to find which by calculation, first, for the distance AD it will be (by rectangular trigonometry,)

S, A : BD :: R : AD.

i. e. As the sine of the course	42°, 33' -	9.83010
is to the departure -	116 -	2.06446
so is radius -	-	10.00000
to the direct distance -	171.5 -	2.23436

Then for the proper difference of latitude, it will be, (by rectangular trigonometry,)

T, A : BD :: R : AB,

i. e. as the tang. of the course	42°, 33'	9.96281
is to the departure -	116 -	2.06446
so is radius -	-	10.00000
to the proper difference of latitude	126.4	2.10165

equal to 2° 6': consequently the ship has come to the latitude of 52° 30' north; and so the meridional difference of latitude will be 212.2.

2. Produce AB to E, till AE be equal to 212.2; and through E draw EC parallel to BD, meeting AD produced in C; then EC will be the difference of longitude; to find which by calculation, it will be, (by rectangular trigonometry,)

R : AE :: T, A : EC.

i. e. As radius -	-	10.00000
is to the merid diff. of latitude	212.2 -	2.32675
so is the tang. of the course	42°, 33'	9.96281
to the min. of diff. of longitude	194.8 -	2.28956

equal to 3° 14' 48", the difference of longitude easterly.

This might have been found otherwise, thus: because the triangles ACE, ADB, are similar; therefore it will be,

AB : BD :: AE : EC.

i. e. As the proper diff. of latitude	126.4	2.10165
is to the departure -	116	2.06446
so is the enlarged diff of lat. -	212.2	2.32675
to min. diff. of longitude -	194.8	2.28956

Case VIII. Both latitudes and departure given, to find course, distance, and difference of longitude.

Example. Suppose a ship from the latitude of 46° 20' N. sails between south and west, till she has made of departure 126.4 miles; and is then found by observation to be in the latitude of 43° 35' north: Required the course and distance sailed, and difference of longitude.

Geometrically. Draw AK (n° 20.) to represent the meridian of the ship in her first latitude; set off upon it AC, equal to 165, the proper difference of latitude. Draw BC perpendicular to AC, equal to 126.4 the departure, and join AB. Set off from A, AK equal to 233.3, the enlarged difference of latitude; and through K draw KD parallel to BC, meeting AB produced in D; so the case is constructed, and DK will be the difference of longitude, AB the distance, and the angle A the course; to find which,

By Calculation:

First, For DC the difference of longitude, it will be,

AC : CB :: AK : KD.

i. e. As the proper diff. of latitude	165	2.21748
is to the departure -	126.4	2.10175
so is the enlarged diff. of latitude	233.3	2.36791
to min. of diff. longitude -	178.7	2.25218

equal to 2° 58' 42", the difference of longitude westerly.

Then for the course it will be, (by rectangular trigonometry,)

AC : BC :: R : T, A.

i. e. As the proper diff. of latitude	165	2.21748
is to departure -	- 126.4	2.10175
so is radius -	-	10.00000
to the tangent of the course	37°, 27'	9.88427

which, because the ship sails between south and west, will be south 37° 27' west, or SW*b*S 6° 30' westerly.

Lastly, For the distance AB, it will be, (by rectangular trigonometry,)

S, A : BC :: R : AB.

i. e. As the sine of the course	37°, 27'	9.78395
is to the departure -	126.4 -	2.10175
so is radius -	-	10.00000
to the direct distance -	207.9 -	2.31780

Case IX. One latitude, distance sailed, and departure given; to find the other latitude, difference of longitude, and course.

Example. Suppose a ship in the latitude of 48° 33' north, sails between south and east 138 miles, and has then made of departure 112.6: Required the latitude come to, the direct course, and difference of longitude.

Geometrically. 1. Draw BD (n° 21.) for the meridian of the ship at B; and parallel to it draw FE, at the distance of 112.6, the departure. Take 138, the distance, in your compasses, and fixing one point of them in B, with the other cross the line FE in the point E; then join B and E, and from E let fall upon BD the perpendicular ED; so BD will be the proper difference of latitude, and the angle B will be the course; to find which, by calculation,

First, For the course it will be, (by rectangular trigonometry,)

BE : R :: DE : S, B.

i. e. As the distance -	138 -	2.13988
is to radius -	-	10.00000
so is the departure -	112.6 -	2.05154
to the sine of the course -	54° 41' -	9.91166

which, because the ship sails between south and east, will be south 54° 41' east, or SE 0° 41' easterly.

Then for the difference of latitude, it will be, (by rectangular trigonometry,)

R : BE :: Co S, B : BD.

i. e. As radius -	-	10.00000
is to the distance -	138 -	2.13988
so is the co-sine of the course	54° 41' -	9.76200
to the difference of latitude	79.8 -	1.90188

equal to 1° 19'. Consequently the ship has come to the latitude of 47° 13'. Hence the meridional difference of latitude will be 117.7.

2dly, Produce B to A, till BA be equal to 117.7; and

PRACTICE

and through A draw AC parallel to DE, meeting BE produced in C; then AC will be the difference of longitude; to find which by calculation, it will be,

BD : DE :: BA : AC.

i. e. As the proper diff. of latitude	79.8	1.90180
is to the departure -	112.6	2.05154
so is the enlarged diff. of latitude	117.7	2.07078
to the diff. of longitude -	166.1	2.22044

equal to 2° 46' 06″, the difference of longitude easterly.

10. From what has been said, it will be easy to solve a traverse according to the rules of Mercator's sailing.

Example. Suppose a ship at the Lizard in the latitude 50° 00' north, is bound to the Madera in the latitude of 32°, 20' north, the difference of longitude tween them being 11°, 40', the west end of the Madera lying so much to the westward of the Lizard, and consequently the direct course and distance (by *Case* 2. *of this Sect.*), is south 26° 15' west 1181.9 miles; but by reason of the winds she is forced to sail on the following courses, (allowance being made for lee-way and variation, &c.), *viz.* SSW 44 miles, S*b*W ½ west 36 miles, SW*b*S 56 miles, and S*b*E 28 miles: Required the latitude the ship is in, her bearing and distance from the Lizard, and her direct course and distance from the Madera, at the end of these courses.

The geometrical construction of this traverse is performed by laying down the two ports according to construction of *Case* 2. *of this Section*, and the several courses and distances according to *Case* 3. by which we have the following solution by calculation.

1. Course SSW, distance 44 miles.

For difference of latitude.

As radius - - -		10.00000
is to the distance -	44 -	1.64345
so is the co-sine of the course	22°, 30'	9.96562
to the difference of latitude	40.65	1.60907

and since the course is southerly, therefore the latitude come to will be 49° 20' north, and consequently the meridional difference of latitude will be 61.8. Then,

For difference of longitude.

As radius - - -		10.00000
is to the enlarged diff. of lat.	61.8 -	1.79099
so is the tang. of the course	22°, 30' -	9.61722
to min. of diff. of longitude	25.6 -	1.40821

2. Course S*b*W ½ west, distance 36 miles.

For difference of latitude.

As radius - - -		10.00000
is to the distance -	36 -	1.55630
so is the co-sine of the course	16°, 52'	9 98090
to the difference of latitude	34.46 -	1.53720

and since the course is southerly, therefore the latitude come to will be 48° 45'. Hence the meridional difference of latitude will be 53.4. Then,

For difference of longitude.

As radius - - -		10.00000
is to the enlarged diff. of lat.	53.4	1.72754
so is the tang. of the course	16°, 52'	9.48171
to the difference of longitude	16.19	1.20925

3. Course SW*b*S, distance 56 miles.

For difference of latitude.

As radius - - -		10.00000
is to the distance -	56 -	1.74819
so is the co-sine of the course	33°, 45' -	9.91985
to the difference of latitude	46.56 -	1.66804

PRACTICE

consequently the latitude come to is 47° 59'; and therefore the enlarged difference of latitude will be 69.2. Then,

For difference of longitude.

As radius - - -		10.00000
is to the enlarged diff. of lat.	69.2	1.84011
so is the tang. of the course	33°, 45'	9.82489
to the difference of longitude	46.24	1.66500

4. Course S*b*E, distance 28 miles.

For difference of latitude.

As radius - - -		10.00000
is to the distance -	28 -	1.44716
so is the co-sine of the course	11°, 15'	9 99157
to the difference of latitude	27.46	1.43873

consequently the latitude come to will be 47°, 31'; and hence the meridional difference of latitude will be 43.2. Then,

For difference of longitude.

As radius - - -		10.00000
is to the enlarged diff. of lat.	43.2	1.63548
so is the tang. of the course	11°, 15'	9.29866
to the diff. of longitude	8.59 -	0.93414

Now these several courses and distances, together with the difference of latitude and longitude belonging to each of them, being set down in their proper columns in the *Traverse Table*, will stand as follow.

Courses.	*Distances.*	*Diff. of Lat.* *N.*	*S.*	*Diff. of Longit.* *E.*	*W.*
SSW —	44	——	40.65	——	25.6
S*b*W½W —	36	——	34.46	——	16.16
SW*b*S —	56	——	46.56	——	49.24
S*b*E — —	28	——	27.46	8.56	——
	Diff. of Lat.		149.13	8.59	88.03
					0.59
				Diff. of Long.	79.44

Hence it is plain that the ship has made of southing 149.13 minutes, and consequently has come to the latitude of 47° 31' north, and so the meridional difference of latitude between that and her first latitude will be 226.1: And since she has made of difference of longitude 79.44 minutes westerly; therefore, for the direct course and distance between the Lizard and the ship, it will be, (by *Case* 2. *of this Section.*

For the direct course.

As the merid. diff. of latitude	226.1 -	2.35430
is to radius - - -		10.00000
so is the difference of longitude	79.44 -	1.90004
to the tang. of the course -	19° 22' -	9.54593

which, because the difference of latitude is southerly, and the difference of longitude westerly, will be south 19° 22' west, or S*b*W 8° 7' westerly. Then,

For the direct distance.

As radius - - -		10.00000
is to the proper diff. of lat.	149.13 -	2.17349
so is the secant of the course	19° 22' -	10.02530

to

Practice

to the direct diftance -	158 -	2.19879
From the latitude the fhip is in -		47°, 31'N
fubtract the lat. of the Madera -		32 , 20 N
and there remains - -		15 , 11

equal to 911 minutes, the proper difference of latitude between the fhip and the Madera.

Again, from the merid. parts anfwering to the latitude the fhip is in	3248.4
Take the meridional parts anfwering to the latitude of the Madera	2052.0
and there remains - - -	1196.4

the enlarged difference of latitude between the fhip and the Madera.

Alfo, from the diff. of long. between the Lizard and the Madera	11°, 40' W
Take the difference of of lon. between the Lizard and the fhip	1 , $19\frac{44}{100}$ W
and there remains - -	10 , $20\frac{56}{100}$W

equal to 620.56 min. of difference of longitude between the fhip and the Madera wefterly.

Then for the direct courfe and diftance between the fhip and the Madera, it will be,

For the direct courfe:

As the merid. diff. of latitude	1196.4	3.07788
is to radius - -		10.00000
fo is the difference of longitude	620.56	2.79278
to the tang. of the courfe	27°, 25'	9.71493

For the direct diftance:

As radius - - -		10.00000
is to the proper diff. of latitude	911	2.95952
fo is the fecant of the courfe	27°, 25'	10.05174
to the direct diftance -	1027	3.01126

11. It is very common in working a day's reckoning at fea, to find the difference of latitude and departure to each courfe and diftance; and adding all the departures together, and all the differences of latitudes for the whole departure, and difference of latitude made good that day, from thence (by *Cafe* 8. *of this Section*) to find the difference of longitude, &c. made good that day. Now that this method is falfe, will evidently appear, if we confider that the fame departure, reckoned on two different parallels, will give unequal differences of longitude; and confequently, when feveral departures are compounded together and reckoned on the fame parallel, the difference of longitude refulting from that cannot be the fame with the fum of the differences of longitude refulting from the feveral departures on different parallels; and therefore we have chofen, in the laft *example* of a *traverfe*, to find the difference of longitude anfwering to each particular courfe and diftance, the fum of which muft be the true difference of longitude made good by the fhip on thefe feveral courfes and diftances.

12. We fhewed, at *Art.* 3. *of this Section*, how to conftruct a *Mercator's chart*; and now we fhall proceed to its feveral ufes, contained in the following problems.

Prob. I. Let it be required to lay down a place upon the chart, its latitude, and the difference of longitude between it and fome known place upon the chart being given.

Example. Let the known place be the Lizard lying on the parallel of 50° 00' north, and the place to be laid down St Katharine's on the eaft coaft of America, differing in longitude from the Lizard 42° 36', lying fo much to the weftward of it.

Let L reprefent the Lizard on the chart, (fee N° 12.) lying on the parallel of 50° 00' north, its meridian. Set off AE from E upon the equator EQ 42° 36', towards Q, which will reach from E to F. Through F draw the meridian FG, and this will be the meridian of St Katharine's; then fet off from Q to H upon the graduated meridian QB, 28 degrees; and thro' H draw the parallel of latitude HM, which will meet the former meridian in K, the place upon the chart required. Plate CCII.

Prob. II. Given two places upon the chart, to find their difference of latitude and difference of longitude.

Through the two places draw parallels of latitude; then the diftance between thefe parallels, numbered in degrees and minutes upon the graduated meridian, will be the difference of latitude required; and thro' the two places drawing meridians, the diftance between thefe, counted in degrees and minutes on the equator or any graduated parallel, will be the difference of longitude required.

Prob. III. To find the bearing of one place from another upon the chart.

Example. Required the bearing of St Katharine's at K (fee N° 12.) from the Lizard at L.

Draw the meridian of the Lizard AE, and join K and L with the right line KL; then by the line of chords meafuring the angle KLE, and with that entering the tables, we fhall have the thing required.

This may alfo be done, by having compaffes drawn on the chart, (fuppofe at two of its corners); then lay the edge of a ruler over the two places, and let fall a perpendicular, or take the neareft diftance from the centre of the compafs next the firft place, to the ruler's edge; then with this diftance in your compaffes, flide them along by the ruler's edge, keeping one foot of them clofe to the ruler, and the other as near as you can judge perpendicular to it, which will defcribe the rhumb required.

Prob. IV. To find the diftance between two given places upon the chart.

This problem admits of four cafes, according to the fituation of the two places with refpect to one another.

Case I. When the given places lie both upon the equator.

In this cafe their diftance is found by converting the degrees of difference of longitude intercepted between them into minutes.

Case II. When the two places lie both on the fame meridian.

Draw the parallels of thofe places; and the degrees upon the graduated meridian, intercepted between thofe parallels, reduced to minutes, give the diftance required.

Case III. When the two places lie on the fame parallel.

Example. Required to find the diftance between the points K and N (fee N° 12.) both lying on the parallel of 28° 00' north. Take from your fcale the chord

Practice chord of 60° or radius in your compaffes, and with that extent on KN as a bafe make the ifofceles triangle KPN; then take from the line of fines the co-fine of the latitude, or fine of 72°, and fet that off from P to S and T. Join S and T with the right line ST, and that applied to the graduated equator will give the degrees and minutes upon it equal to the diftance; which, converted into minutes, will be the diftance required.

The reafon of this is evident from the fection of *Parallel Sailing:* for it has been there demonftrated, that radius is to the co-fine of any parallel, as the length of any arch on the equator, to the length of the fame arch on that parallel. Now in this chart KN is the diftance of the meridians of the two places K and N upon the equator; and fince, in the triangle PNK, ST is the parallel to KN, therefore PN : PT : : NK : TS. Confequently TS will be the diftance of the two places K and N upon the parallel of 28°.

If the parallel the two places lie on be not far from the equator, and they not far afunder; then their diftance may be found thus: Take the diftance between them in your compaffes, and apply that to the graduated meridian, fo as the one foot may be as many minutes above as the other is below the given parallel; and the degrees and minutes intercepted, reduced to minutes, will give the diftance.

Or it may alfo be found thus: Take the length of a degree on the meridian at the given parallel, and turn that over on the parallel from the one place to the other, as oft as you can; then as oft as that extent is contained between the places, fo many times 60 miles will be contained in the diftance between them.

Case IV. When the places differ both in longitude and latitude.

Example. Suppofe it were required to find the diftance between the two places *a* and *e* upon the chart. By Prob. II. Find the difference of latitude between them; and take that in your compaffes from the graduated equator, which fet off on the meridian of *a*, from *a* to *b;* then thro' *b* draw *bc* parallel to *de;* and taking *ac* in your compaffes, apply it to the graduated equator, and it will fhew the degrees and minutes contained in the diftance required, which multiplied by 60 will give the miles of diftance.

The reafon of this is evident from *Art. 6. of this Section:* for it is plain *ad* is the enlarged difference of latitude, and *ab* the proper; confequently *ae* the enlarged diftance, and *ac* the proper.

Prob. V. To lay down a place upon the chart, its latitude and bearing from fome known place upon the chart being known, or (which is the fame) having the courfe and difference of latitude that a fhip has made, to lay down the running of the fhip, and find her place upon the chart.

Example. A fhip from the Lizard in the latitude of 50° 00' north, fails SSW till fhe has differed her latitude 36° 40'. Required her place upon the chart.

Count from the Lizard at L, on the graduated meridian downwards (becaufe the courfe is foutherly) 36° 40' to *g*; through which draw a parallel of latitude, which will be the parallel the fhip is in; then from L draw a SSW line L*f*, cutting the former parallel in *f*, and this will be the fhip's place upon the chart. Practice

Prob. VI. One latitude, courfe, and diftance, failed, given; to lay down the running of the fhip, and find her place upon the chart.

Example. Suppofe a fhip at *a* in the latitude of 20° 00' north, fails north 37° 20', eaft 191 miles: Required the fhip's place upon the chart.

Having drawn the meridian and parallel of the place *a*, fet off the rhumb-line *ae*, making with *ab* an angle of 37° 20'; and upon it fet off 191 from *a* to *c;* thro' *c* draw the parallel *cb;* and taking *ab* in your compaffes, apply it to the graduated equator, and obferve the number of degrees it contains; then count the fame number of degrees on the graduated meridian from C to *b*, and through *b* draw the parallel *he*, which will cut *ac* produced in the point *e*, the fhip's place required.

Prob. VII. Both latitudes and diftance failed, given; to find the fhip's place upon the chart.

Example. Suppofe a fhip fails from *a*, in the latitude of 20° 00' north, between north and eaft 191 miles, and is then in the latitude of 45° 00' north: Required the fhip's place upon the chart.

Draw *de* the parallel of 45°, and fet off upon the meridian of *a* upwards, *ab* equal to the proper difference of latitude taken from the equator or graduated parallel. Through *b* draw *bc* parallel to *de;* then with 191 in your compaffes, fixing one foot of them in *a*, with the other crofs *be* in *c*. Join *a* in *c* with the right line *ac;* which produced will meet *de* in *e*, the fhip's place required.

Prob. VIII. One latitude, courfe, and difference of longitude, given; to find the fhip's place upon the chart.

Example. Suppofe a fhip from the Lizard in the latitude of 50° 00' north, fails SW*b*W, till her difference of longitude is 42° 36': Required the fhip's place upon the chart.

Having drawn AE the meridian of the Lizard at L, count from E to F upon the equator 42° 36'; and through F draw the meridian EG; then from L draw the SW*b*W line LK, and where this meets FG, as at K, will be the fhip's place required.

Prob. IX. One latitude, courfe, and departure, given; to find the fhip's place upon the chart.

Example. Suppofe a fhip at *a* in the latitude of 20° 00' north, fails north 37° 20' eaft, till fhe has made of departure 116 miles: Required the fhip's place upon the chart.

Having drawn the meridian of *a*, at the diftance of 116, draw parallel to it the meridian *kl*. Draw the rhumb-line *ac*, which will meet *kl* in fome point *c;* then through *c* draw the parallel *cb*, and *ab* will be the proper difference of latitude, and *bc* the departure. Take *ab* in your compaffes, and apply it to the equator or graduated parallel; then obferve the number of degrees it contains, and count fo many on the graduated meridian from C upwards to *b*. Through *b* draw the parallel *he*, which will meet *ac* produced in fome point as *e*, which is the fhip's place upon the chart.

Prob. X. One latitude, diftance, and departure, given; to find the fhip's place upon the chart.

Example. Suppofe a fhip at *a* in the latitude of 20° 00' north, fails 191 miles between north and eaft, and then

PRACTICE then is found to have made of departure 116 miles: Required the ſhip's place upon the chart.

Having drawn the meridian and parallel of the place *a*, ſet off upon the parallel *am* equal to 116, and thro' *m* draw the meridian *kl*. Take the given diſtance 191 in your compaſſes; ſetting one foot of them in *a*, with the other croſs *kl* in *c*. Join *ac*, and through *c* draw the parallel *cb*; ſo *cb* will be the departure, and *ab* the proper difference of latitude; then proceeding with this, as in the foregoing problem, you will find the ſhip's place to be *e*.

PROB. XI. The latitude failed from, difference of latitude, and departure, given; to find the ſhip's place upon the chart.

EXAMPLE. Suppoſe a ſhip from *a* in the latitude of 20° 00' north, fails between north and eaſt, till ſhe be in the latitude of 45° 00' north, and is then found to have made of departure 116 miles: Required the ſhip's place upon the chart.

Having drawn the meridian of *a*, ſet off upon it, from *a* to *b*, 25 degrees, (taken from the equator or graduated parallel), the proper difference of latitude; then through *b* draw the parallel *bc*, and make *bc* equal to 116 the departure, and join *ac*. Count from the parallel of *a* on the graduated meridian upwards to *b* 25 degrees, and through *b* draw the parallel *be*, which will meet *ac* produced in ſome point *e*, and this will be the place of the ſhip required.

13. In the ſection of *Plane Sailing*, it is plain, that the terms *meridional diſtance*, *departure*, and *difference of longitude*, were ſynonimous, conſtantly ſignifying the ſame thing; which evidently followed from the ſuppoſition of the earth's ſurface being projected on a plane in which the meridians were made parallel, and the degrees of latitude equal to one another and to thoſe of the equator. But ſince it has been demonſtrated (in this ſection) that if, in the projection of the earth's ſurface upon a plane, the meridians be made parallel, the degrees of latitude muſt be unequal, ſtill increaſing the nearer they come to the pole; it follows, that theſe terms muſt denote lines really different from one another.

§ 6. *Of Oblique Sailing.*

THE queſtions that may be propoſed on this head being innumerable, we ſhall only give a few of the moſt uſeful.

PROB. I. Coaſting along the ſhore, I ſaw a cape bear from me NNE; then I ſtood away NW*b*W 20 miles, and I obſerved the ſame cape to bear from me NE*b*E: Required the diſtance of the ſhip from the cape at each ſtation.

Plate CCIII. GEOMETRICALLY. Draw the circle NWSE (N° 22.) to repreſent the compaſs, NS the meridian, and WE the eaſt and weſt line, and let C be the place of the ſhip in her firſt ſtation; then from C ſet off upon the NW*b*W line, CA 20 miles, and A will be the place of the ſhip in her ſecond ſtation.

From C draw the NNE line CB, and from A draw AB parallel to the NE*b*E line CD, which will meet CB in B the place of the cape, and CB will be the diſtance of it from the ſhip in its firſt ſtation, and AB the diſtance in the ſecond: to find which,

By CALCULATION;

In the triangle ABC are given AC, equal to 20 miles; the angle ACB, equal to 78° 45', the diſtance between the NNE and NW*b*W lines; alſo the angle ABC, equal to BCD, equal to 33° 45', the diſtance between the NNE and NE*b*E lines; and conſequently the angle A, equal to 67° 30'.

Hence for CB, the diſtance of the cape from the ſhip in her firſt ſtation, it will be (by oblique trigonometry)

S. ABC : AC :: S. BAC : CB,

i. e. As the ſine of the angle B	33° 45'	- 9.74473
is to the diſtance run AC -	20 —	- 1.30103
ſo is the ſine of BAC -	67, 30	- 9.96562
to CB - -	33.26	- 1.52191

the diſtance of the cape from the ſhip at the firſt ſtation. Then for AB, it will be, by oblique trigonometry,

S. ABC : AC :: S. ACB : AB.

i. e. as the ſine of B -	33°, 45'	- 9.74474
is to AC - -	20 —	- 1.30103
ſo is the ſine of C -	78 - 45	- 9.99157
to AB - -	35.31	- 1.54786

the diſtance of the ſhip from the cape at her ſecond ſtation.

PROB. II. Coaſting along the ſhore, I ſaw two headlands; the firſt bore from me NE*b*E 17 miles, the other SSW miles: Required the bearing and diſtance of theſe headlands from one another.

GEOMETRICALLY. Having drawn the compaſs NWSE (N° 23.) let C repreſent the place of the ſhip; ſet off upon the NE*b*E line CA 17 miles from C to A, and upon the SSW line CB 20 miles from C to B, and join AB: then A will be the firſt headland, and B the ſecond; alſo AB will be their diſtance, and the angle A will be the bearing from the NE*b*N line: to find which,

By CALCULATION;

In the triangle ACB are given, AC 17, CB 20, and the angle ACB equal to 101° 15', the diſtance between the NE*b*E and SSW lines. Hence (by oblique angular trigonometry) it will be

As the ſum of the ſides AC and CB -	37	1.56820
is to their difference - -	3	0.47712
ſo is the tang. of ½ the ſum of the angles A and B -	39°, 22½	9.91417
to the tang. of half their diff. -	3 , 49	8.82309

conſequently the angle A will be 43° 11', and the angle B 35° 34'; alſo the bearing of B from A will be S*b*W 1° 49' weſterly, and the bearing of A from B will be N*b*E 1° 49' eaſterly.

Then for the diſtance AB, it will be, (by oblique angular trigonometry),

S. A : CB :: S. C : AB.

i. e. As the ſine of A -	43°, 11' -	9.83527
is to CB - -	20 -	1.30103
ſo is the ſine of C -	101, 15 -	9.99157
to AB - -	28.67 -	1.45733

the diſtance between the two headlands.

PROB. III. Coaſting along the ſhore, I ſaw two headlands; the firſt bore from me NW*b*N, and the ſecond NNE; then ſtanding away E*b*N ¾ northerly 20 miles, I found the firſt bore from me WNW ½ weſterly, and the ſecond N*b*W ½ weſterly: Required the bearing and diſtance of theſe two headlands.

GEOMETRICALLY. Having drawn the compaſs NWSE (N° 24.) let C repreſent the firſt place of the ſhip;

PRACTICE ſhip; from which draw the NW*b*N line CB, and the NNE line CD, alſo the E*b*N $\frac{3}{4}$ N line CA, which make equal to 20. From A draw AB parallel to the WNW $\frac{1}{4}$ W line, and AD parallel to the N*b*W $\frac{1}{4}$ W meeting the two firſt lines in the points B and D; then B will be the firſt and D the ſecond headlands. Join the points B and D, and BD will be the diſtance between them, and the angle CDB the bearing from the NNE line: to find which,

By Calculation;

1. In the triangle ABC are given the angle BCA, equal to 104° 04′, the diſtance between the NW*b*N line, and the ENE$\frac{1}{4}$E line; the angle BAC, equal to 36° 34′, the diſtance between the WSW$\frac{1}{4}$W line and the WNW $\frac{1}{4}$ W line; the angle ABC equal to 39° 22′, the diſtance between the ESE $\frac{1}{2}$ E line; and the SW*b*S line, alſo the ſide CA equal to 20 miles: whence for CB, it will be (by oblique trigonometry)

As the ſine of CBA	39°, 22′	9.80228
is to AC	20	1.30103
ſo is the ſine of CAB	36°, 34′	9.77507
to CB	18.79	1.27382

the diſtance between the firſt headland and the ſhip in her firſt ſtation.

2. In the triangle ACD, are given the angle ACD, equal to 47° 49′, the diſtance between the ENE$\frac{1}{4}$E line, and the NNE line; the angle CAD, equal to 92° 49′, the diſtance between the WSW$\frac{1}{4}$W line; and the N*b*W$\frac{1}{4}$W line, the angle CDA equal to 39° 22′, the diſtance between the SSW line and the S*b*E$\frac{1}{2}$E line; alſo the leg CA equal to 20.

Hence for CD, it will be (by oblique trigonometry)

As the ſine CAD	39°, 22′	9.80228
is to AC	20	1.30103
ſo is the ſine of CAD	92°, 34′	9.99960
to CD	31.5	1.49835

the diſtance between the ſecond headland and the ſhip in her firſt ſtation.

3. In the triangle BCD are given BC 18.79, CD 31.5, and the angle BCD equal to 56° 15′, the diſtance between the NW*b*N line and the NNE line.

Hence for the angle CDB, it will be (by oblique trigonometry)

As the ſum of the ſides	50.29	1.70148
is to the difference of ſides	12.71	1.10415
ſo is tangent of $\frac{1}{2}$ ſum of the unknown angles	61°, 51′	10.27189
to tang. of half their diff.	25, 18	9.67458

conſequently the angle CBD is 87° 10′, and the angle CDB 36° 35′. Hence the bearing of the firſt headland from the ſecond will be S 59° 8′, W or SW*b*W$\frac{1}{2}$W nearly; and for the diſtance between them, it will be,

As the ſine of BDC	36°, 35′	9.77524
is to BC	18.79	1.27382
ſo is the ſine of BCD	56°, 15′	9.91985
to BD	26.21	1.41843

the diſtance between the two headlands.

This, and the firſt problem, are of great uſe in drawing the plot of any harbour, or laying down any ſea-coaſt.

Suppoſe a ſhip that makes her way good within 6$\frac{1}{2}$ points of the wind, at north, is bound to a port bearing eaſt 86 miles diſtance from her: Required the courſe and diſtance upon each tack, to gain the intended port. PRACTICE

Geometrically. Having drawn the compaſs NE SW, (N° 25.) let C repreſent the ſhip's place, and ſet off upon the eaſt line CA 86 miles, ſo A will be the intended port. Draw CD and CB on each ſide of the north line at 6$\frac{1}{2}$ points diſtance from it, and through A draw AB parallel to CD meeting CB in B; then the ENE$\frac{1}{2}$E line CB, will be the courſe of the ſhip upon the ſtarboard tack, and CB its diſtance on that tack; alſo the ESE$\frac{1}{2}$E line Ab, will be the courſe on the larboard tack, and BA the diſtance on that tack: to find which,

By Calculation;

In the triangle ABC are given the angle ACB, equal to 16° 53′, the diſtance between the eaſt and ENE$\frac{1}{2}$E line; the angle CBA, equal to 146° 14′, the diſtance between the ENE$\frac{1}{2}$E and the WNW$\frac{1}{4}$W lines; the angle BAC equal to 16° 53, the diſtance between the eaſt and ESE$\frac{1}{2}$E lines; alſo AC 86 miles.

Hence, ſince the angle at A and C are equal, the legs CB and BA will likewiſe be equal; to find either of which (ſuppoſe CB) it will be (by oblique angled trigonometry)

As the ſine of B	146°, 14′	9.74493
is to AC	86	1.93450
ſo is the ſine of A	16.53	9.46303
to CB	44.94	1.65260

the diſtance the ſhip muſt ſail on each tack.

There is a great variety of uſeful queſtions of this nature that may be propoſed; but the nature of them being better underſtood by practice at ſea, we ſhall leave them, and go on to *Great Circle Sailing*.

§ 6. *Great Circle Sailing*.

A great many caſes might be propoſed in this kind of ſailing; but as they ſerve rather for exerciſes in the ſolution of ſpheric triangles than for any real uſe towards the navigating of a ſhip, we ſhall only give the ſolution of one problem, as being the moſt generally uſeful.

Prob. Given the latitudes and longitudes of two places on the earth: Required the neareſt diſtance on the ſurface, together with the angles of poſition (or that which a great circle, paſſing over both places, makes with the meridian of one of them) from either place to the other.

Case I. When both places lie under the ſame meridian, their difference of latitude ſhews their neareſt diſtance.

Case II. When the two places lie under the equator, their diſtance is equal to the difference of longitude between them.

Case III. When the places lie under the ſame parallel of latitude.

Example. What is the leaſt diſtance between St Mary's in Lat. 37° 00′ N. Long. 25° 0′ W. and Cape Henry, in Lat. 37° 00′ Long. 76° 23′ weſt?

Deſcribe a circle PESQ repreſenting the meridian Plate CCI. of one of the places; ſuppoſe of the eaſtern one, as fig. 6. St Mary's; draw the line EQ repreſenting the equator, and at right angles to it draw the line PS, for the axis of the earth, the extremity of which, P, is the north pole, and S the ſouth pole; and on this circle lay off from P to A the complement of the lati-

latitude of St Mary's, the eastern place. On the equator, from Q to C, lay off the difference of longitude between the two places; and through the points P, C, S, describe a circle, which will be the meridian of the other place Cape Henry; on which lay from P to B the co-latitude of this place, which is done by describing the arc A*a* about the pole P according to the rules of projection, at the distance of the co-latitude. Through the points ABD describe a great circle; then will A represent St Mary's, and B Cape Henry; PA and PB are their co-latitudes; the angle APB, which is measured by the arc QC, is the difference of longitude; the arc AB is the nearest distance of these places; the angle PAB is the angle of position from A to B; and the angle PBA is the angle of position from B to A. The arc AB, and the angle PAB or PBA, may be measured according to the rules laid down under the article Projection. Now, the places having the same latitude, PA is equal to PB, and the angles PAB and PBA are likewise equal. Therefore if the arc PI be described, making the angle API = 25° 41½', the half of the difference of longitude; PI will be perpendicular to AB, and bisect it. And in the triangle AIP, right-angled at I, there will be given the hypothenuse AP = 53° 00' the angle API = 25° 41½'; to find the leg AI = half the distance sought, and the angle PAI = the angle of position. Then, for the distance: As radius is to the sine of the hypothenuse PA, so is the sine of the given angle API to the sine of the leg AI. Or,

As radius	= 90° 00'	-	10.00000
To cos. lat.	= 37 00	-	9.90235
So sine ½ diff. long.	= 25 41½	-	9.63702
To sine ½ dist.	= 20 75½	-	9.53937

which doubled, gives 40° 31' for the distance; and this distance, reduced to nautical miles, is 2431; less by 31 than that given by parallel sailing.—For the angle of position, As radius is to the co-sine of the hypothenuse PA, so is the tangent of the given angle API to the co-tangent of the angle A. Or,

As radius	= 90° 00'	-	10.00000
To sine lat.	= 37 00	-	9.77946
So tang. ½ dif. long.	= 25 41½	-	9.68222
To co-tang. ang. posit.	= 73 51	-	9.46168

Hence it appears, that to sail from A to B, or from B to A, the ship must first steer N. 73° 51' W. or E. and then gradually increase her course till she comes to I, where it will be due west or east; and from thence the course is to be gradually diminished again till she comes to the other port, where it will be 73° 51', the same as she set out with.

Case IV. When one place has latitude, and the other has none.

Example. What is the nearest distance between the island of St Thomas, in lat. 0° 00', and long. 1°? The co-latitude of St Julian is 41° 09'; and the difference of longitude between the two places is 66° 10'.—Let the point A (plate CCI. fig. 7.) be St Thomas, and P and S the north and south poles. Make AC, the measure of the angle ASC, equal to 66° 10' the difference of longitude. Then, as Port St Julian is in south latitude, about S the south pole at the distance of Julian's co-latitude, describe the arc *aa*, cutting SCP, the meridian of Julian in B, through the points A, B, E, a great circle being described, the arc AB is the distance sought. The distances and angles may now be measured according to the rules of projection, or it falls under a case in spheric trigonometry: for, in the quadrantal triangle ASB, there are given the co-latitude of St Thomas or AS = 90° 00'; the co-latitude of St Julian, or SB = 41° 09'; the difference of longitude, or the angle ASB = 66° 10', from whence all the rest may be found. Or, in the supplemental triangle, ACB, right-angled at C, there is given the latitude of St Julian's, or the leg CB = 48° 51'; the difference of longitude, or the leg CA = 66° 10', whence the rest may easily be found; and hence it will appear, that a ship sailing from the island of St Thomas must first shape her course south 51° 22' W; and then, by constantly altering her course towards the west, so as to arrive at Port St Julian on a course S. 71° 36' W. she will have sailed the shortest distance between these places.

Case V. When the latitudes of the given places are both north, or both south.

Example. What is the nearest distance between the Lizard and the island of Bermudas, and also the angles of position?—The difference of longitude of the two places is 58° 11'.

Make PA (Plate CCI. fig. 8.) = 57° 25', the co-latitude of Bermudas; P*a* = 40° 03', the co-latitude of the Lizard; and with the tangent of P*a* describe the arc *aa*. With the secant of 58° 11', the difference of longitude, describe arcs from P and S, which gives the centre of the circle PCS the meridian of the Lizard; its intersection with *aa* gives B, the place of the Lizard. The arcs of the circle and angles may be measured by spheric trigonometry as before. Had the eastern place, the Lizard, been put upon the primitive circle, the great circle AB would have been difficult to describe; and therefore the western place was put upon it, it being a matter of indifference which of the places are so taken.

Case VI. When one of the given places has north latitude, and the other has south latitude.

Example. What is the nearest distance from the island of St Helena to the island of Bermudas, and also the angles of position at each place; the difference of longitude between the two being 57° 43'?

Make QA (fig. 9.) = 15° 55', the lat. of St Helena; describe the arc *aa* about P, with the tangent of P*a* = 57° 25', the co-latitude of Bermudas. Arcs described from P, S, with the secant of 57° 43', the difference of longitude, will give the centre of the circle PCS, the meridian of Bermudas; and its intersection B with *aa*, is the place of Bermudas. Describe a great circle through A, B, D; the intercepted arc AB is the distance sought; and the angles PAB, ABS, are the positions required, which must be measured according to the rules of spheric trigonometry. From the solutions of these triangles it will appear, that when a ship sails from St Helena to Bermudas on the arc of a great circle, she must first shape her course N. 48° 00' W. and gradually alter it from the north towards the west, so as to arrive at Bermudas on a course N 50° 01' west, after having run 73° 26', or 4406 miles. The course found by Mercator's sailing is N. 48° 45' W. and the distance is 4414 miles.——By this it appears

Practice.

pears, that when the places are one in N. latitude, and the other in S. latitude; neither of them being very far from the equator, there is but a ſmall difference between the reſults found by Mercator's and great circle failing: for, near the equator, the rhumb-lines do not differ much from great circles.

From the ſolution of the foregoing caſes, it is plain, that to fail on the arc of a great circle, the ſhip muſt continually alter her courſe. But as this is a difficulty too great to be admitted into the practice of navigation, it has been thought ſufficiently exact to effect this buſineſs by a kind of approximation, founded upon this principle, that, in ſmall arcs, the difference between the arc and its tangent is ſo little, that they may be taken one for the other in any nautical operations. Upon this principle, the great circles of the earth are ſuppoſed to be made up of ſhort right lines, each of which is a ſegment of a rhumb-line. And on this ſuppoſition the ſolution of the following problem is founded.

Having given the latitudes and longitudes of the places failed from, and bound to; to find the ſucceſſive latitudes on the arc of a great circle in thoſe places where the alteration in longitude ſhall be a given quantity; together with the courſes and diſtances between thoſe places.

1. Find the angle of poſition at each place, and their diſtance by one of the preceding ſix caſes.

2. Find the greateſt latitude the great circle runs through; that is, find the perpendicular from the pole to that circle; and alſo find the ſeveral angles at the pole, made by the given alterations of longitude between this perpendicular and the ſucceſſive meridians come to.

3. With this perpendicular, and the polar angles ſeverally find as many correſponding latitudes, by ſaying:

As rad. : tan. greateſt lat. : : coſ. 1 polar ang. : tan. 1 lat.
: : coſ. 2 polar ang. : tan. 2 lat.
&c. &c.

4. Having the ſeveral latitudes paſſed thro', and the difference of longitude between each, find, by Mercator's failing, the courſes and diſtances between thoſe latitudes,

And theſe are the ſeveral courſes and diſtances the ſhip muſt run to keep nearly on the arc of a great circle.

The ſmaller the alterations in longitude are taken, the nearer will this method approach the truth; but it is ſufficient to compute to every five degrees of difference of longitude, the length of an arc of five degrees differing from its chord or tangent only by 0.0002.

Example. A ſhip being bound from a place in lat. 37° 00' N. lon. 22° 56' W. to a place in the ſame lat. and in lon. 76° 23' W. it is propoſed ſhe ſhall fail as near the arc of a great circle as ſhe can, by altering her courſe at every five degrees difference of longitude: Required the latitude at each time of altering the courſe, and alſo the courſes and diſtances between thoſe ſeveral latitudes.

Place failed from lat. is 37° 00' N.	the long.	22° 56' W.
Place bound to lat. is 37 00 N.	the long.	76 23 W.
	The diff. of long.	53 27

The figure being deſcribed, and the computation made, the diſtance BA is found to be 42° 06', and the angle A or the angle B=73° 09', the angle of poſition. Plate CCI. fig. 10.

Now the triangle APB, being iſoſceles, the perpendicular PI falls in the middle of AB; and the latitudes, courſes, and diſtances, being known in running the half BI, thoſe in the half IA will alſo be known.

Let the points *a*, *b*, *c*, *d*, &c. be the places arrived at on each alteration of five degrees of longitude: then will the arcs P*a*, P*b*, P*c*, P*d*, &c. be the reſpective co-latitudes of thoſe places, and are the hypothenuſes of the right-angled ſpheric triangles PI*a*, PI*b*, PI*c*, PI*d*, &c.

In the triangle PIB.
Given PB = 53° 00'
the angle PBI = 73 09
To find PI.

As rad.	= 90° 00'	10.00000
To ſin. PB	= 53 00	9.90235
So ſin. the ang. B	= 73 09	9.98094
To ſin. PI	= 49 51	9.88329

Now the angle IPB $=\left(\frac{53^\circ\ 27'}{2}\right)$ 26° 43½'; the angle IP*a*=21° 43½'; the angle IP*b*=16° 43½'; the angle IP*c* =11° 43½'; the angle IP*d*=6° 43½', are the ſeveral polar angles.

		21° 43½'	16° 43½'	11° 43½'	6° 43½'
Then rad.	= 90° 00'	10.00000	10.00000	10.00000	10.00000
To co-tang. PI	= 49 51	9.92612	9.92612	9.92612	9.92612
So co-ſine polar angle		9.96800	9.98123	9.99084	9.99700
To tang. lat.		9.89412	9.90735	9.91696	9.92312
	Which are	38° 05'	38° 56'	39° 33'	39° 57'

The degrees and min. ſet over each column, are the polar angles uſed in that proportion, and the correſponding latitudes ſtand at bottom.

The firſt term of theſe proportions being radius, and the ſecond term *conſtant*, the operations may be very expeditiouſly performed thus.

On a ſlip of paper let the log. of the ſecond or conſtant term be written of the ſame ſize with the printed figures; apply this log. co-tang. ſucceſſively to the log. co-ſines of the polar angles: Then the ſum of the

the two log^s. being written down each time, will give the log. tangents of the feveral latitudes arrived at.

By this method, each proportion will be worked by writing down only one line.

Hence it appears, the fhip muft firft fail from the lat. 37° 00' N. to lat. 38° 05' N.; thence to lat. 38° 56' N.; thence to lat. 39° 33'; thence to lat. 39° 57' N.; thence to lat. 40° 09' N., which is the greateft latitude fhe muft go to; and from thence fhe muft proceed through the latitudes 39° 57', 39° 33', 38° 56', 38° 05', and fo to 37° 00', the parallel fhe fet out from, and in which fhe is to find the place fhe is bound to.

Now between thefe feveral latitudes, with the refpective differences of longitude, find by Mercator's failing the courfes and diftances.

If the refults of the feveral operations, in the queftions of great circle failing be entered in fuch a table as the following, it will be found of fome convenience to the operator.

Polar angles.	Succeff. longs.	Succeff. lats.	Diff. long.	Diff. lat.	Merid. parts.	Merid. diff. lat.	Cour.	Dift.
The angle IPB 26° 43½'	22° 56'	37° 00'			2392.6			
IP*a* 21 43½	27 56	38 05	300	65	2474.6	82.0	74.43	246.6
IP*b* 16 43½	32 56	38 56	300	51	2539.8	65.2	77.44	240.0
IP*c* 11 43¼	37 56	39 33	300	37	2587.6	47.8	80.57	235.2
IP*d* 6 43½	42 56	39 57	300	24	2618.8	31.2	84.04	232.2
	49 39½	40 09	403.5	12	2634.5	15.7	87.46	307.9
								1261.9

In the firft column are the angles at the pole contained between the perpendicular and the feveral meridians differing by 5° of longitude.

In the fecond column, the departed longitude 22° 56' being increafed by the differences of longitude, make the fucceffive longitudes come to.

In the third column are the fucceffive latitudes paffed thro' in failing from the place fet out from to the greateft latitude.

In the fourth and fifth columns are the differences between the longitudes and latitudes in the fecond and third columns.

In the fixth column are the meridional parts to the fucceffive latitudes; and in the feventh column are the meridional diff. of latitudes.

The eight and ninth columns contain the courfes and diftances between the places anfwering to the fecond and third columns.

The numbers in the third, eighth, and ninth columns, are found by working the logarithmic proportions on a wafte paper; but the work is here omitted, as it is fo eafily fupplied.

Now the column of diftances being fummed up amounts to 1261.9; which being doubled, gives 2523.8 miles for the diftance between the two places.

And the courfes the fhip muft fteer are, 1ft, N. 74° 43'W.; 2d, N. 77° 44'W.; 3d, N. 80° 57'W.; 4th, N. 84° 04'W.; 5th, N. 87° 46'W.; 6th, S. 87° 46'W.; 7th, S. 84° 04'W.; 8th, S. 80° 57'W.; 9th, S. 77° 44'W.; 10th, S. 74° 43'W.: and on thefe courfes fhe muft run the refpective diftances ftanding againft them.

Having now fhown the method of folving the different cafes of navigation mathematically, and fuppofing the courfe of the fhip and diftance run to be always exactly known, we fhall now proceed to give an account of thofe mechanical methods by which the fhip's courfe is obferved, and the frequent variations and errors in it corrected at convenient times.

§ 7. *Of the Log-line and Compafs.*

1. The method commonly made ufe of for meafuring a fhip's way at fea, or how far fhe runs in a given fpace of time, is by the Log-line, and Half-minute Glafs.

2. The log, fig. 3. is generally about a quarter of an inch thick, and five or fix inches from the angular point *a* to the circumference *b*. It is balanced by a thin plate of lead, nailed upon the arch, fo as to fwim perpendicularly in the water, with about ⅔ impreffed under the furface. The line is faftened to the log by means of two legs *a* and *b*, fig. 2. one of which paffes thro' a hole *a* at the corner, and is knotted on the oppofite fide; whilft the other leg is attached to the arch by a pin *b*, fixed in another hole, fo as to draw out occafionally. By thefe legs the log is hung *in equilibrio*, and the line, which is united to it, is divided into certain fpaces, which are in proportion to an equal number of geographical miles, as a half minute or quarter minute is to an hour of time. Plate CLXI.

3. Thefe fpaces are called *knots*, becaufe at the end of each of them there is a piece of twine with knots in it, inreeved between the ftrands of the line, which fhews how many of thefe fpaces or knots are run out during the half minute. They commonly begin to be counted at the diftance of about 10 fathom or 60 feet from the log; that fo the log, when it is hove overboard, may be out of the eddy of the fhip's wake before they begin to count; and for the more ready difcovery of this point of commencement, there is commonly faftened at it a piece of red rag.

4. The log being thus prepared, and hove overboard from the poop, and the line veered out (by the help of a reel (fig. 4.) that turns eafily, and about which it is wound) as faft as the log will carry it away, or rather as the fhip fails from it, will fhew, according to the time of veering, how far the fhip has run in a given time, and confequently her rate of failing.

5. A degree of a meridian, according to the exacteft meafures, contains about 69.545 Englifh miles; and each mile by the ftatute being 5280 feet, therefore a degree of a meridian will be about 367,200 feet; whence the $\frac{1}{60}$ of that, *viz.* a minute, or nautical mile, muft contain 6120 ftandard feet; confequently, fince ½ minute

$\frac{1}{2}$ minute is the $\frac{1}{120}$ part of an hour, and each knot being the ſame part of a nautical mile, it follows, that each knot will contain the $\frac{1}{120}$ of 6120 feet, *viz.* 51 feet.

6. Hence it is evident, that whatever number of knots the ſhip runs in half a minute, the ſame number of miles ſhe will run in one hour, ſuppoſing her to run with the ſame degree of velocity during that time; and therefore it is the general way to heave the log every hour to know her rate of ſailing: but if the force or direction of the wind vary, and not continue the ſame during the whole hour; or if there has been more ſail ſet, or any ſail handed, that ſo the ſhip has run ſwifter or ſlower in any part of the hour than ſhe did at the time of heaving the log; then there muſt be an allowance made accordingly for it, and this muſt be according to the diſcretion of the artiſt.

7. Sometimes, when the ſhip is before the wind, and there is a great ſea ſetting after her, it will bring home the log, and conſequently the ſhip will ſail faſter than is given by the log. In this caſe it is uſual, if there be a very great ſea, to allow one mile in ten, and leſs in proportion, if the ſea be not ſo great. But for the generality, the ſhip's way is really greater than that given by the log; and therefore, in order to have the reckoning rather before than behind the ſhip, (which is the ſafeſt way), it will be proper to make the ſpace on the log-line between knot and knot to conſiſt of 50 feet inſtead of 51.

8. If the ſpace between knot and knot on the log-line ſhould happen to be too great in proportion to the half-minute glaſs, *viz.* greater than 50 feet, then the diſtance given by the log will be too ſhort; and if that ſpace be too ſmall, then the diſtance run (given by the log) will be too great: therefore, to find the true diſtance run in either caſe, having meaſured the diſtance between knot and knot, we have the following proportion, *viz.*

As the true diſtance, 50 feet, is to the meaſured diſtance; ſo are the miles of diſtance given by the log, to the true diſtance in miles that the ſhip has run.

Example I. Suppoſe a ſhip runs at the rate of $6\frac{1}{4}$ knots in half a minute; but meaſuring the ſpace between knot and knot, I find it to be 56 feet: Required the true diſtance in miles.

Making it, As 50 feet is to 56 feet, ſo is 6.25 knots to 7 knots; I find that the true rate of ſailing is 7 miles in the hour.

Example II. Suppoſe a ſhip runs at the rate of $6\frac{1}{2}$ knots in half a minute; but meaſuring the ſpace between knot and knot, I find it to be only 44 feet: Required the true rate of ſailing.

Making it, As 50 feet is to 44 feet, ſo is 6.5 knots to 5.72 knots; I find that the true rate of ſailing is 5.72 miles in the hour.

9. Again, ſuppoſing the diſtance between knot and knot on the log-line to be exactly 50 feet, but that the glaſs is not 30 ſeconds; then, if the glaſs require longer time to run than 30 ſeconds, the diſtance given will be too great, if eſtimated by allowing one mile for every knot run in the time the glaſs runs; and, on the contrary, if the glaſs requires leſs time to run than 30 ſeconds, it will give the diſtance ſailed too ſmall. Conſequently, to find the true diſtance in either caſe, we muſt meaſure the time the glaſs requires to run out (by the method in the following article); then we have the following proportion, *viz.*

As the number of ſeconds the glaſs runs, is to half a minute, or 30 ſeconds; ſo is the diſtance given by the log, to the true diſtance.

Example I. Suppoſe a ſhip runs at the rate of $7\frac{1}{2}$ knots in the time the glaſs runs; but meaſuring the glaſs, I find it runs 34 ſeconds: Required the true diſtance ſailed.

Making it, As 34 ſeconds is to 30 ſeconds, ſo is 7.5 to 6.6; I find that the ſhip ſails at the rate of 6.6 miles an hour.

Example II. Suppoſe a ſhip runs at the rate of $6\frac{1}{2}$ knots; but meaſuring the glaſs, I find it runs only 25 ſeconds: Required the true rate of ſailing.

Making it, As 25 ſeconds is to 30 ſeconds, ſo is 6.5 knots to 7.8 knots; I find that the true rate of ſailing is 7.8 miles an hour.

10. In order to know how many ſeconds the glaſs runs, you may try it by a watch or clock that vibrates ſeconds; but if neither of theſe be at hand, then take a line, and to the one end faſtening a plummet, hang the other upon a nail or peg, ſo as the diſtance from the peg to the centre of the plummet be $39\frac{1}{5}$ inches: then this put into motion will vibrate ſeconds; *i. e.* every time it paſſes the perpendicular, you are to count one ſecond; conſequently, by obſerving the number of vibrations that it makes during the time the glaſs is running, we know how many ſeconds the glaſs runs.

11. If there be an error both in the log-line and half-minute glaſs, *viz.* if the diſtance between knot and knot and the log-line be either greater or leſs than 50 feet, and the glaſs runs either more or leſs than 30 ſeconds; then the finding out the ſhip's true diſtance will be ſomewhat more complicate, and admit of three caſes, *viz.*

Case I. If the glaſs runs more than 30 ſeconds, and the diſtance between knot and knot be leſs than 50 feet, then the diſtance given by the log-line, viz. by allowing 1 mile for each knot the ſhip ſails while the glaſs is running, will always be greater than the true diſtance, ſince either of theſe errors gives the diſtance too great. Conſequently, to find the true rate of ſailing in this caſe, we muſt firſt find (by Art. 8.) the diſtance, on the ſuppoſition that the log-line is only wrong, and then with this (by Art. 9.) we ſhall find the true diſtance.

Example. Suppoſe a ſhip is found to run at the rate of 6 knots; but examining the glaſs, I find it runs 35 ſeconds; and meaſuring the log-line, I find the diſtance between knot and knot to be but 46 feet: Required the true diſtance run.

Firſt, (by Art. 8.) We have the following proportion, viz. As 50 feet : 46 feet :: 6 knots : 5.52 knots. Then (by Art. 9.) As 35 ſeconds : 30 ſeconds :: 5.52 knots : 4.73 knots. Conſequently the true rate of ſailing is 4.73 miles an hour.

Case II. If the glaſs be leſs than 30 ſeconds, and the place between knot and knot be more than 50 feet; then the diſtance given by the log will always be leſs than the true diſtance, ſince either of theſe errors leſſens the true diſtance.

Example. Suppoſe a ſhip is found to run at the rate of 7 knots; but examining the glaſs, I find it runs only 25 ſeconds; and meaſuring the ſpace between

tween knot and knot on the log-line, I find it is 54 feet: Required the true rate of failing.

Firft, (by Art 9.) As 25 feconds : 30 feconds : : 7 knots : 8.4 knots. Then (by Art 8.) As 50 feet : 54 feet : : 8.4 knots : 9.072 knots. Confequently the true rate of failing is 9.072 miles an hour.

Case III. If the glafs runs more than 30 feconds, and the fpace between knot and knot be greater than 50 feet; or if the glafs runs lefs than 30 feconds, and the fpace between knot and knot be lefs than 50 feet: then, fince in either of thefe two cafes the effects of the errors are contrary, it is plain the diftance will fometimes be too great, and fometimes too little, according as the greater quantity of the error lies; as will be evident from the following examples.

Example I. Suppofe a fhip is found to run at the rate of $9\frac{1}{2}$ knots per glafs; but examining the glafs, it is found to run 36 feconds; and by meafuring the fpace ketween knot and knot, it is found to be 58 feet: Required the true rate of failing.

Firft, (by Art. 8.) As 50 feet : 58 feet : : 9.5 knots : 11.02 knots. Then (by Art. 9.) As 38 feconds : 30 feconds : : 11.02 knots : 8.7 knots. Confequently the fhip's true rate of failing is 8.7 miles an hour.

Example II. Suppofe a fhip runs at the rate of 6 knots per glafs; but examining the glafs, it is found to run only 20 feconds; and by meafuring the log-line, the diftance between knot and knot is found to be but 38 feet: Required the true rate of failing.

Firft, (by Art. 8.) As 50 feet : 38 feet : : 6 knots : 4.56 knots. Then (by Art. 9.) As 20 feconds : 30 feconds : : 4.56 knots : 6.84 knots. Confequently the true rate of failing is 6.83 miles an hour.

But if in this cafe it happen, that the time the glafs takes to run be to the diftance between knot and knot, as 30, the feconds in half a minute, is to 50, the true diftance between knot and knot; then it is plain, that whatever number of feconds the glafs confifts of, and whatever number of feet is contained between knot and knot, yet the diftance given by the log-line will be the true diftance in miles.

12. Though the method of meafuring the fhip's way by the log-line, defcribed in the foregoing articles, be that which is now commonly made ufe of; yet it is fubject to feveral errors, and thefe very confiderable. For, firft, the half-minute or quarter-minute glaffes (by which and the log the fhip's way is determined) are feldom or never true, becaufe dry and wet weather have a great influence on them; fo that at one time they may run more, and at another time fewer, than 30 feconds; and it is evident that a fmall error in the glafs will caufe a fenfible one in the fhip's way. Again, the chief property of the log is to have it fwim upright, or perpendicular to the horizon: but this is too often wanting in logs, becaufe few feamen examine whether it is fo or not, and generally take it upon truft, being fatisfied if it weigh a little more at the ftern than the head. And from this there flows an error in the reckoning; for if the log does not fwim upright, it will not hold water, nor remain fteady in the place where it is heaved, fince the leaft check in the hand in veering the line will make it come up feveral feet: this repeated will make the errors become fathoms, and perhaps knots, which, how infignificant foever they appear, are miles and parts of miles, and amount to a good deal in a long voyage. Another inconvenience attending the log-line is its ftretching and fhrinking; for when a new line is firft ufed, let it be ever fo well ftretched upon the deck, and meafured as true as poffible, yet after wetting it fhrinks confiderably; and confequently to be the better affured of the fhip's way by the log-line, we ought to meafure and alter the knots on it every time before we ufe it; but this is feldom done oftener than once a-week, and fometimes not above once or twice in a whole voyage: alfo when the line is meafured to its greateft degree of fhrinking, it is generally left there; and when, by much ufe, it comes to ftretch again, it is feldom or never mended, though it will ftretch beyond what it firft fhrunk. Thefe and many other errors, too well known, attending that method of meafuring the fhip's way by the log-line, plainly accounts for a great many errors committed in reckonings. So it is to be wifhed, that either this method were improved or amended, or that fome other method lefs fubject to error were found out.

13. The meridian and prime vertical of any place cuts the horizon in 4 points, at 90 degrees diftance from one another, viz. *North*, *South*, *Eaft* and *Weft*; that part of the *meridian* which extends itfelf from the place to the *north* point of the *horizon* is called the *north line*; that which tends to the *fouth* point of the horizon is called the *fouth line*; and that part of the *prime vertical* which extends towards the right hand of the obferver, when his face is turned to the *north*, is called the *eaft line*; and laftly, that part of the *prime vertical* which tends towards the left hand is called the *weft line*; the four points in which thefe lines meet the *horizon* are called the *cardinal points*.

14. In order to determine the courfe of the winds, and to difcover their various alterations or fhiftings, each quadrant of the horizon, intercepted between the meridian and prime vertical, is ufually divided into eight equal parts, and confequently the whole horizon into thirty-two; and the lines drawn from the place on which the obferver ftandeth, to the points of divifion in his horizon, are called *rhumb-lines*; the four principal of which are thofe defcribed in the preceding article, each of them having its name from the cardinal point in the horizon towards which it tends: the reft of the rhumb-lines have their names compounded of the principal lines on each fide of them, as in the figure (Plate CII. N° 1.); and over whichfoever of thefe lines the courfe of the wind is directed, that wind takes its name accordingly.

15. The inftrument commonly ufed at fea for directing the fhip's way is called the Mariner's Compass; which confifts of a card and two boxes. The card is a circle made to reprefent the horizon, whofe circumference is quartered and divided into degrees, and alfo into thirty-two equal parts, by lines drawn from the centre to the feveral points of divifion, called *points of the compafs*. On the back-fide of the card, and juft below the fouth and north line, is fixed a fteel needle with a brafs cupola, or hollow centre in the middle, which is placed upon the end of a fine pin, upon which the card may eafily turn about: the needle is touched with a loadftone, by which a certain virtue is infufed into it, that makes it (and confequently the fouth and north line on the card above it) hang nearly in the plane of the meridian; by which means the fouth and

north lines on the card produced would meet the horizon in the south and north points; and consequently all the other lines on the card produced would meet the horizon in the respective points.

Plate CCII. 16. The card is represented in N° 1. in which you may observe, that the capital letters N, S, E, W, denote the four cardinal points, *viz.* N the *North*, S the *South*, &c. and the small letter *b* signifies the word *by*. The *rhumbs* in the middle between any two of the cardinals are expressed by the letters denoting these cardinals, that which denotes the point lying in the meridian having the precedence; thus the rhumb in the middle between the north and east is expressed N. E. which is to be read *North-east*; also S. W. denotes the *South-west* rhumb, &c.: the other rhumbs are expressed according to their situation with respect to these middle rhumbs and the nearest cardinals, as is plain from the foresaid figure.

17. The card is put into a round box, made for it, having a pin erected in the middle, upon which the hollow centre of the needle is fixed, so as the card may lie horizontal, and easily vibrate according to the motion of the needle: the box is covered over with a smooth glass, and is hung in a brass hoop upon two cylindrical pins, diametrically opposite to one another; and this hoop is hung within another brass circle, upon two pins at right angles with the former. These two circles, and the box, are placed in another square wooden box, so that the innermost box, and consequently the card, may keep horizontal which way soever the ship heels.

18. Since the meridians do all meet at the poles, and there form certain angles with one another; and since, if we move ever so little towards the east or west, from one place to another, we thereby change our meridian, and in every place the east and west line being perpendicular to the meridian; it follows, that the east and west line in the first place will not coincide with the east and west line in the second, but be inclined to it at a certain angle: and consequently all the other rhumb-lines at each place will be inclined to each other, they always forming the same angles with the meridian. Hence it follows, that all rhumbs, except the four cardinals, must be curves or helispherical lines, always tending towards the pole, and approaching it by infinite gyrations or turnings, but never falling into it. Thus let P (N° 2.) be the pole, EQ an arch of the equator, PE, PA, &c. meridians, and EFGHKL any rhumb: then because the angles PEF, PFG, &c. are by the nature of the rhumb-line equal, it is evident that it will form a curve-line on the surface of the globe, always approaching the pole P, but never falling into it; for if it were possible for it to fall into the pole, then it would follow, that the same line could cut an infinite number of other lines at equal angles, in the same point; which is absurd.

19. Because there are 32 rhumbs (or points in the compass) equally distant from one another, therefore the angle contained between any two of them adjacent will be 11° 15', viz. $\frac{1}{32}$ part of 360°; and so the angle contained between the meridian and the N*b*E, will be 11° 15', and between the meridian and the NNE will be 22° 30'; and so of the rest, as in the following table.

A Table of the Angles which every $\frac{1}{4}$ Point of the Compass makes with the Meridian.

North	*South*	*Points*	D.	M.	*North*	*South*
		$\frac{1}{4}$	02	49		
		$\frac{1}{2}$	05	37		
		$\frac{3}{4}$	08	26		
N*b*E	S*b*E	1	11	15	N*b*W	S*b*W
		1 $\frac{1}{4}$	14	04		
		1 $\frac{1}{2}$	16	52		
		1 $\frac{3}{4}$	19	41		
NNE	SSE	2	22	30	NNW	SSW
		2 $\frac{1}{4}$	25	19		
		2 $\frac{1}{2}$	28	07		
		2 $\frac{3}{4}$	30	56		
NE*b*N	SE*b*S	3	33	45	NW*b*N	SW*b*W
		3 $\frac{1}{4}$	36	34		
		3 $\frac{1}{2}$	39	22		
		3 $\frac{3}{4}$	42	11		
NE	SE	4	45	00	NW	SW
		4 $\frac{1}{4}$	47	49		
		4 $\frac{1}{2}$	50	37		
		4 $\frac{3}{4}$	53	26		
NE*b*E	SE*b*E	5	56	15	NW*b*W	SW*b*W
		5 $\frac{1}{4}$	59	04		
		5 $\frac{1}{2}$	61	52		
		5 $\frac{3}{4}$	64	42		
ENE	ESE	6	67	30	WNW	WSW
		6 $\frac{1}{4}$	70	19		
		6 $\frac{1}{2}$	73	07		
		6 $\frac{3}{4}$	75	56		
E*b*N	E*b*S	7	78	45	W*b*N	W*b*S
		7 $\frac{1}{4}$	81	34		
		7 $\frac{1}{2}$	84	22		
		7 $\frac{3}{4}$	87	11		
East		8	90	00	*West*	

§ 8. *Concerning Currents, and how to make proper allowances.*

1. Currents are certain settings of the stream, by which all bodies (as ships, &c.) moving therein, are compelled to alter their course or velocity, or both; and submit to the motion impressed upon them by the current.

Case I. If the current sets just with the course of the ship, *i. e.* moves on the same rhumb with it; then the motion of the ship is increased, by as much as is the drift or velocity of the current.

Example. Suppose a ship sails SE*b*S at the rate of 6 miles an hour, in a current that sets SE*b*S 2 miles an hour: Required her true rate of sailing.

Here it is evident that the ship's true rate of sailing will be 8 miles an hour.

Case II. If the current sets directly against the ship's course, then the motion of the ship is lessened by

Practice

by as much as is the velocity of the current.

Example. Suppoſe a ſhips ſails SSW at the rate of 10 miles an hour, in a current that ſets NNE 6 miles an hour: Required the ſhip's true rate of ſailing.

Here it is evident that the ſhip's true rate of ſailing will be 4 miles an hour. Hence it is plain,

Cor. I. If the velocity of the current be leſs than the velocity of the ſhip, then the ſhip will get ſo much a-head as is the difference of theſe velocities.

Cor. II. If the velocity of the current be greater than that of the ſhip, then the ſhip will fall ſo much a-ſtern as is the difference of theſe velocities.

Cor. III. Laſtly, If the velocity of the current be equal to that of the ſhip, then the ſhip will ſtand ſtill; the one velocity deſtroying the other.

Case III. If the current thwarts the courſe of the ſhip, then it not only leſſens or augments her velocity, but gives her a new direction compounded of the courſe ſhe ſteers, and the ſetting of the current, as is manifeſt from the following

Lemma. If a body at A (N° 26.) be impelled by two forces at the ſame time, the one in the direction AB capable to carry that body from A to B in a certain ſpace of time, and the other in the direction AD capable to carry it from A to D in the ſame time; complete the parallelogram ABCD, and draw the diagonal AC; then the body at A, agitated by theſe two forces together, will move along the line BC, and will be in the point C at the end of the time in which it would have moved along AD or AB with the forces ſeparately applied.

Hence the ſolution of the following examples will be evident.

Example I. Suppoſe a ſhip ſails (by the compaſs) directly ſouth 96 miles in 24 hours, in a current that ſets eaſt 45 miles in the ſame time: Required the ſhip's true courſe and diſtance.

Plate CCIII

Geometrically. Draw AD (ſee N° 26.) to repreſent the ſouth and north line of the ſhip at A, which make equal to 96; from D draw DC perpendicular to AD, equal to 45; and join AC. Then C will be the ſhip's true place, AC her true diſtance, and the angle CAD the true courſe. To find which,

By Calculation;

Firſt, For the true courſe DAC, it will be, (by rectangular trigonometry),

As the apparent diſtance AD	96	1.98227
is to the current's motion DC	45	1.65321
ſo is radius		10.00000
to the tangent of the true courſe DAC	25°, 07′	9.67094

conſequently the ſhip's true courſe is S 25° 07′ E, or SSE 2° 37′ eaſterly.

Then for the true diſtance AC, it will be, (by rectangular trigonometry),

As the ſine of the courſe A	25°, 07′	9.62784
is to the departure DC	45	1.65321
ſo is radius		10.00000
to the true diſtance AC	106	2.02537

Example. Suppoſe a ſhip ſails SE 120 miles in 20 hours, in a current that ſets W*b*N at the rate of 2 miles an hour: Required the ſhip's true courſe and diſtance ſailed in that time.

Geometrically. Having drawn the compaſs NESW (N° 27.) let C repreſent the place the ſhip ſailed from; draw the SE line CA, which make equal to 120; then will A be the place the ſhip caped at.

Practice

From A draw AB parallel to the W*b*N line CD, equal to 40, the motion of the current in 20 hours, and join CB; then B will be the ſhip's true place at the end of 20 hours, CB her true diſtance, and the angle SCB her true courſe. To find which,

By Calculation;

In the triangle ABC, are given CA 120, AB 40, and the angle CAB equal to 34° 45′, the diſtance between the E*b*S and SE lines, to find the angles B and C, and the ſide CB.

Firſt, For the angles C and B, it will be, (by oblique trigonometry),

As the ſum of the ſides CA and AB	160	2.20412
is to their difference	80	1.90309
ſo is the tang. of half the ſum of the angles B and C	73°, 07′	10.51783
to the tang. of half their diff.	59, 45	10.21680

conſequently the angle B will be 131, 52, and the angle ACB 14° 23′. Hence the true courſe is S 30° 37′ E, or SSE 2° 07′ eaſterly.

Then for the true diſtance CB, it will be, (by oblique trigonometry),

As the ſine of B	131°, 52′	9.87198
is to AC	120	2.07918
ſo is the ſine of A	33°, 45′	9.74474
to the true diſtance CB	89.53	1.95194

Example III. Suppoſe a ſhip coming out from ſea in the night, has ſight of Scilly light, bearing NE*b*N diſtance 4 leagues, it being then flood tide ſetting ENE 2 miles an hour, and the ſhip running after the rate of 5 miles an hour: Required upon what courſe and how far ſhe muſt ſail to hit the Lizard, which bears from Scilly E½S diſtance 17 leagues.

Geometrically. Having drawn the compaſs NESW (N° 28.) let A repreſent the ſhip's place at ſea, and draw the NE*b*N line AS, which make equal to 12 miles; ſo S will repreſent Scilly.

From S draw SL equal to 51 miles, and parallel to the E½S line; then L with repreſent the Lizard.

From L draw LC parallel to the ENE line, equal to 2 miles, and from C draw CD equal to 5 miles meeting AL in D; then from A draw AB parallel to CD meeting LC produced in B; and AB will be the required diſtance, and SAB the true courſe. To find which,

By Calculation;

In the triangle ASL are given the ſide AS equal to 12 miles, the ſide SL equal to 51, and the angle ASL equal to 118° 07′, the diſtance between the NE*b*N and W½N lines; to find the angles SAL and SLA. Conſequently, (by oblique trigonometry), it will be,

As the ſum of the ſides AS and SL	63	1.79934
is to their difference	39	1.59106
ſo is the tang of half the ſum of the angles SAL and SLA	30°, 56′	9.77763
to the tang. of half their diff.	20°, 21′	9.56935

conſequently the angle SAL, will be 51° 17′; and ſo the direct bearing of the Lizard from the ſhip will be N 85° 02′ E, or E*b*N 6° 17′ E; and for the diſtance AL, it will be, (by oblique trigonometry),

Practice

As the ſine of SAL	51°, 17'	9.89223
is to SL	51	1.70757
ſo is the ſine of ASL	118°, 07'	9.94546
to AL	57.65	1.76080

the diſtance between the ſhip and the Lizard.

Again, in the triangle DLC, are given the angle L equal to 17° 32', the diſtance between the ENE and N 85° 02' E lines; the ſide LC, equal to 2 miles, the current's drift in an hour; and the ſide CD, equal to 5 miles, the ſhip's run in the ſame time. Hence for the angle D, it will be, (by oblique trigonometry),

As the ſhip's run in 1 hour DC	5	0.69897
is to the ſine of L	17°, 32'	9.47894
ſo is the current's drift LC	2	0.30103
to the ſine of D	6°, 55'	9.08100

conſequently, ſince by conſtruction the angle LAB is equal to the angle LDC, the courſe the ſhip muſt ſteer is S 88°, 03' E.

Then for the diſtance AB, it will be, (by oblique trigonometry),

As the ſine of B	155°, 33'	9.61689
is to AL	57.65	1.76080
ſo is the ſine of L	17.32	9.47894
to AB	41.96	1.62285

conſequently, ſince the ſhip is ſailing at the rate of 5 miles an hour, it follows, that in ſailing $8^h\ 24^m$ S 88° 03' E, ſhe will arrive at the Lizard.

Example IV. A ſhip from a certain headland in the latitude of 34° 00' north, ſails SE*b*S 12 miles in 3 hours, in a current that ſets between north and eaſt; and then the ſame headland is found to bear WNW, and the ſhip to be in the latitude of 33° 52' north: Required the ſetting and drift of the current.

Geometrically. Having drawn the compaſs NESW (N° 29.) let A repreſent the place of the ſhip, and draw the SE*b*S line AB, equal to 12 miles, alſo the ESE line AC.

Set off from A upon the meridian AD, equal to 8 miles, the difference of latitude, and through D draw DC parallel to the eaſt and weſt line WE, meeting AC in C. Join C and B with the right line BC; then C will be the ſhip's place, the angle ABC the ſetting of the current from the SE*b*S line, and the line BC will be the drift of the current in 3 hours. To find which,

By Calculation;

In the triangle ABC, right-angled at D, are given the difference of latitude AD equal to 8 miles, the angle DAC equal to 67° 30'. Whence for AC, the diſtance the ſhip has ſailed, it will be

As radius		10.00000
is to the diff. of latitude AD	8	0.90309
ſo is the ſecant of the courſe DAC	67°, 30'	10.41716
to the diſtance run AC	20.9	1.32025

Again, in the triangle ABC, are given AB equal to 12 miles, AC equal to 20.9, and the angle BAC equal to 30° 45', the diſtance between the SE*b*S and ESE lines. Whence, for the angle at B, it will be,

As the ſum of the ſides AC and AB	32.9	1.51720
is to their difference	8.9	0.94930
ſo is the tang. of half the ſum of the angles B and C	73°, 07'	10.51806
to tang. of ½ their diff.	41°, 43' ½	9.95025

conſequently the angle B is 114° 51'; and ſo the ſetting of the current will be N 81° 06' E, or E*b*E 2° 21' E. Then for BC, the current's drift in 3 hours, it will be,

As the ſine of B	114°, 51'	9.92700
is to the diſtance run AC	20.9	1.32025
ſo is the ſine of A	33°, 45'	9.74474
to BC	12.8	1.10719

the current's drift in 3 hours; and conſequently the current ſets E*b*N 2° 21' E 4.266 miles an hour.

Practice

§. 9. *Concerning the* Variation *of the* Compass, *and how to find it from the true and obſerved* Amplitudes *or* Azimuths *of the ſun.*

1. The variation of the compaſs is how far the north or ſouth point of the needle ſtands from the true ſouth or north point of the horizon towards the eaſt or weſt; or it is an arch of the horizon intercepted between the meridian of the place of obſervation and the magnetic meridian.

2. It is abſolutely neceſſary to know the variation of the compaſs at ſea, in order to correct the ſhip's courſe; for ſince the ſhip's courſe is directed by the compaſs, it is evident that if the compaſs be wrong, the true courſe will differ from the obſerved, and conſequently the whole reckoning differ from the truth.

3. The ſun's true amplitude is an arch of the horizon comprehended between the true eaſt or weſt point thereof, and the centre of the ſun at riſing or ſetting; or it is the number of degrees, &c. that the centre of the ſun is diſtant from the true eaſt or weſt point of the horizon, towards the ſouth or north.

4. The ſun's magnetic amplitude is the number of degrees that the centre of the ſun is from the eaſt or weſt point of the compaſs, towards the ſouth or north point of the ſame at riſing or ſetting.

5. Having the declination of the ſun, together with the latitude of the place of obſervation, we may from thence find the ſun's true amplitude, by the following aſtronomic propoſition, viz.

As the co-ſine of the latitude
is to the radius
So is the ſine of the ſun's declination
to the ſine of the ſun's true amplitude
which will be north or ſouth according as the ſun's declination is north or ſouth.

Example. Required the ſun's true amplitude in the latitude of 41° 50' north, on the 23d day of April 1731.

Firſt, I find (from the tables of the ſun's declination) that the ſun's declination the 23d of April is 15° 54' north; then for the true amplitude, it will be, by the former analogy,

As the co-ſine of the lat.	41° 50'	9.87221
is to radius		10.00000
ſo is the ſine of the decl.	15°, 54',	9.43769
to the ſine of the amplit.	21, 35,	9.56548

which is north, becauſe the declination is north at that time; and conſequently, in the latitude of 40° 50' north, the ſun riſes on the 23d of April 21° 35' from the eaſt part of the horizon towards the north, and ſets ſo much from the weſt the ſame way.

6. The ſun's true azimuth is the arch of the horizon intercepted between the meridian and the vertical circle paſſing through the centre of the ſun at the time of obſervation.

7. The

PRACTICE

7. The ſun's magnetic azimuth is the arch of the horizon, intercepted between the magnetic meridian and the vertical, paſſing through the ſun.

8. Having the latitude of the place of obſervation, together with the ſun's declination and altitude at the time of obſervation, we may find his true azimuth after the following method, viz.

Make it,

As the tangent of half the complement of the latitude is to the tangent of half the ſum of the diſtance of the ſun from the pole and complement of the altitude

So is the tangent of half the difference between the diſtance of the ſun from the pole and complement of the altitude

To the tangent of a fourth arch

which fourth arch added to half the complement of the latitude will give a fifth arch, and this fifth arch leſſened by the complement of the latitude will give a ſixth arch.

Then make it,

As the radius

is to the tangent of the altitude

ſo is the tangent of the ſixth arch

to the co-ſine of the ſun's azimuth

which is to be counted from the ſouth or north, to the eaſt or weſt, according as the ſun is ſituated with reſpect to the place of obſervation.

If the latitude of the place and declination of the ſun be both north or both ſouth, then the declination taken from 90° will gives the ſun's diſtance from the pole; but if the latitude and declination be on contrary ſides of the equator, then the declination added to 90° will give the ſun's diſtance from the neareſt pole to the place of obſervation.

EXAMPLE. In the latitude of 51° 32' north, the ſun having 19° 39' north declination, his altitude was found by obſervation to be 38° 18: Required the azimuth.

By the firſt of the foregoing analogies, it will be

As the tangent of ½ the complement of the latitude	19°, 14'	9.54269
is to the tangent of ½ the ſum of the diſtance of the ſun from the pole and complement of the altitude	61 „ 01	10.25655
ſo is the tangent of half their difference -	9 „ 19	7.21499
to the tang. of a 4th arch	40 „ 20	9.92885

which fourth arch 40° 20', added to 19° 14', half the complement of the latitude, gives a fifth arch 59° 34'; and this fifth arch leſſened by 38° 28', the complement of the latitude, gives the ſixth arch 21° 06'; then for the azimuth, it will be, by the ſecond of the preceding analogies,

As radius - - -		10.00000
is to the tang. of the altitude	38°, 18'	9.89749
ſo is the tang. of the ſixth arch	21 „ 06 -	9.58644
to the co-ſine of the azimuth	72 „ 15 -	9.48393

which, becauſe the latitude is north and the ſun ſouth of the place of obſervation, muſt be counted from the ſouth towards the eaſt or weſt; and conſequently, if the altitude of the ſun was taken in the morning, the azimuth will be S 72° 15' E, or ESE 4° 45' E; but if the altitude was taken in the afternoon, the azimuth will be S 72° 15' W, or WSW 4° 45' weſterly.

PRACTICE

9. Having found the ſun's true amplitude or azimuth by the preceding analogies, and his magnetic amplitude or azimuth by obſervation, it is evident, if they agree, there is no variation; but if they diſagree, then if the true and obſerved amplitudes at the riſing or ſetting of the ſun be both of the ſame name, *i. e.* either both north, or both ſouth, their difference is the variation; but if they be of different names, *i. e.* one north and the other ſouth, their ſum is the variation. Again, if the true and obſerved azimuth be both of the ſame name, *i. e.* either both eaſt or both weſt, their difference is the variation: but if they be of different names, their ſum is the variation: And to know whether the variation is eaſterly, obſerve this general rule, viz.

Let the obſerver's face be turned to the ſun: then if the true amplitude or azimuth be to the right-hand of the obſerved, the variation is eaſterly; but if be to to the left, weſterly.

To explain which, Let NESW (N° 30.) repreſent a compaſs, and ſuppoſe the ſun is really E*b*S at the time of obſervation, but the obſerver ſees him off the eaſt point of the compaſs, and ſo the true amplitude or azimuth of the ſun is to the right of the magnetic or obſerved; here it is evident that the E*b*S point of the compaſs ought to lie where the eaſt point is, and ſo the north where the N*b*W is; conſequently the north point of the compaſs is a point too far eaſt, *i. e.* the variation in this caſe is eaſterly. The ſame will hold when the amplitude or azimuth is taken on the weſt ſide of the meridian. Plate CCIII

Again, let the true amplitude or azimuth be to the left-hand of the obſerved. Thus, ſuppoſe the ſun is really E*b*N at the time of obſervation, but the obſerver ſees him off the eaſt point of the compaſs, and ſo the true amplitude or azimuth to the left of the obſerved: Here it is evident that the E*b*N point of the compaſs ought to ſtand where the eaſt point is, and ſo the north where the N*b*E point is; conſequently the north point of the compaſs lies a point too far weſterly; ſo in this caſe the variation is weſt. The ſame will hold when the ſun is obſerved on the weſt ſide of the meridian.

EXAMPLE I. Suppoſe the ſun's true amplitude at riſing is found to be E 14° 20' N, but by the compaſs it is found to be E 26° 12': Required the variation, and which way it is.

Since they are both the ſame way, therefore

From the magnetic amplitude -	E 26°, 12' N.
take the true amplitude -	E 14 , 20 N.
and there remains the variation -	11 , 52 E.

which is eaſterly, becauſe in this caſe the true amplitude is the right of the obſerved.

EXAMPLE II. Suppoſe the ſun's true amplitude at ſetting is W 34° 26' S, and his magnetic amplitude W 23° 13' S: Required the variation, and which way it is.

Since they lie both the ſame way, therefore

From the ſun's true amplitude -	W 43°, 26' S.
take his magnetic amplitude -	W 23 , 13 S.
there remains the variation -	11 , 13 W.

which

which is westerly, because the true amplitude, in this case, is to the left-hand of the observed.

Example III. Suppose the sun's true altitude at rising is found to be 13° 24' N, and his magnetic E 12° 32' S: Required the variation, and which way it lies.

Since the true and observed amplitudes lie different ways, therefore

To the true amplitude	-	E 13°, 24' N.
add the magnetic amplitude	-	E 12, 32 S.
the sum is the variation	-	25, 56 W.

which is westerly, because the true amplitude is, in this case, to the left of the observed.

Example IV. Suppose the sun's true altitude at setting is found to be W 8° 24' N, but his magnetic amplitude is W 10° 13' S: Required the variation.

To the true amplitude	-	W 8°, 24' N.
add the magnetic -	-	W 10, 13 S.
the sum is the variation	-	18, 37 E.

which is easterly, because the true amplitude is to the right of the observed.

Example V. Suppose the sun's true azimuth at the time of observation is found to be N 86° 40' E, but by the compass it is N 73° 24' E: Required the variation, and which way it lies.

From the sun's true azimuth	-	N 86°, 40' E.
take the magnetical -	-	N 73, 24 E.
there remains the variation	-	13, 16 E.

which is easterly, because the true azimuth is to the right of the observed.

Example VI. Suppose the sun's true azimuth is S 3° 24' E, and the magnetical S 4° 36' W: Required the variation, and which way it lies.

To the true azimuth -	-	S 3°, 24' E.
add the magnetical azimuth	-	S 4, 36 W.
the sum is the variation	-	8, 00 W.

which is westerly, because the true azimuth is, in this case, to the left of the observed.

10. The variation of the compass was first observed at London, in the year 1580, to be 11° 15' easterly, and in the year 1622 it was 6° 0' E.; also in the year 1634, it was 4° 05' E. still decreasing, and the needle approaching the true meridian, till it coincided with it, and then there was no variation; after which, the variation began to be westerly; and in the year 1672, it was observed to be 2° 30' W.; also in the year 1683, it was 4° 30' W; and since that time the variation still continues at London to increase westerly; but how far it will go that way, time and observations will probably be the only means to discover.

Again, at Paris, in the year 1640, the variation was 3° 00' E.; and in the year 1666, there was no variation; but in the year 1681, it was 2° 30' W. and still continues to go westerly.

In short, from observations made in different parts of the world, it appears, that in different places the variation differs both as to its quantity and denomination, it being east in one place, and west in another; the true cause and theory of which, for want of a sufficient number of observations, has not as yet been fully explained.

§ 10. *The Method of keeping a Journal at sea; and how to correct it, by making proper allowance for the Lee-way, Variation*, &c.

1. Leeway is the angle that the rhumb-line, upon which the ship endeavours to sail, makes with the rhumb she really sails upon. This is occasioned by the force of the wind or surge of the sea, when she lies to the windward, or is close-hauled, which causes her to fall off and glide sideways from the point of the compass she capes at. Thus let NESW (N° 31.) represent the compass; and suppose a ship at C capes at, or endeavours to sail upon, the rhumb C*a*; but by the force of the wind, and surge of the sea, she is obliged to fall off, and make her way good upon the rhumb C*b*: then the angle *a*C*b* is the lee-way; and if that angle be equal to one point, the ship is said to make one point lee-way; and if equal to two points, the ship is said to make two points lee-way, &c.

The quantity of this angle is very uncertain, because some ships, with the same quantity of sail, and with the same gale, will make more lee-way than others; it depending much upon the mould and trim of the ship, and the quantity of water that she draws. The common allowances that are generally made for the lee-way, are as follow.

1. If a ship be close hauled, has all her sails set, the water smooth, and a moderate gale of wind, she is then supposed to make little or no lee-way.

2. If it blow so fresh as to cause the small sails be handed, it is usual to allow one point.

3. If it blow so hard that the top-sails must be close reeft, then the common allowance is two points for lee-way.

4. If one top-sail must be handed, then the ship is supposed to make between two and three points lee-way.

5. When both top-sails must be handed, then the allowance is about four points for lee-way.

6. If it blows so hard as to occasion the fore-course to be handed, the allowance is between $5\frac{1}{2}$ and 6 points.

7. When both main and fore-courses must be handed, then 6 or $6\frac{1}{2}$ points are commonly allowed for lee-way.

8. When the mizen is handed, and the ship is trying a-hull, she is then commonly allowed about 7 points for lee-way.

3. Though these rules are such as are generally made use of, yet since the lee-way depends much upon the mould and trim of the ship, it is evident that they cannot exactly serve to every ship; and therefore the best way is to find it by observation. Thus, let the ship's wake be set by a compass in the poop, and the opposite rhumb is the true course made good by the ship; then the difference between this and the course given by the compass in the binacle, is the lee-way required. If the ship be within sight of land; then the lee-way may be exactly found by observing a point on the land which continues to bear the same way, and the distance between the point of the compass

pass it lies upon, and the point the ship capes at, will be the lee-way. Thus, suppose a ship at C, is lying up NW*b*, towards A; but instead of keeping that course, she is carried on the NNE line CB, and consequently the point B continues to bear the same way from the ship: Here it is evident, that the angle ACB, or the distance between the N*b*W line that the ship capes at, and the NNE line that the ship really sails upon, will be the lee-way.

4. Having the course steered, and the lee-way, given; we may from thence find the true course by the following method, *viz.* Let your face be turned directly to the windward; and if the ship have her larboard tacks on board, count the lee-way from the course steered towards the right hand; but if the starboard tacks be an board, then count it from the course steered towards the left hand. Thus, suppose the wind at north, and the ship lies up within 6 points of the wind, with her larboard tacks on board, making one point lee-way; here it is plain, that the course steered is ENE, and the true course E*b*N: also suppose the wind is at NNW, and the ship lies up within $6\frac{1}{2}$ points of the wind, with her starboard tack on board, making $1\frac{1}{2}$ point lee-way; it is evident that the true course, in this case, is WSW.

5. We have shewed, in the last section, how to find the variation of the compass; and from what has been said there, we have this general rule for finding the ship's true course, having the course steered and the variation given, viz. Let your face be turned towards the point of the compass upon which the ship is steered; and if the variation be easterly, count the quantity of it from the course steered towards the right hand; but if westerly, towards the left hand; and the course thus found is the true course steered. Thus, suppose the course steered is N*b*E, and the variation one point easterly; then the true course steered will be NNE: Also suppose, the course steered is NE*b*E, and the variation one point westerly; then, in this case, the true course will be NE; and so of others.

Hence, by knowing the lee-way variation, and course steered, we may from thence find the ship's true course; but if there be a current under foot, then that must be tried, and proper allowances made for it, as has been shown in the section concerning *Currents*, from thence to find the true course.

6. After making all the proper allowances for finding the ship's true course, and making as just an estimate of the distance as we can; yet by reason of the many accidents that attend a ship in a day's running, such as different rates of sailing between the times of heaving the log; the want of due care at the helm by not keeping her steady, but suffering her to yaw and fall off; sudden storms, when no account can be kept, &c.; the latitude by account frequently differs from the latitude by observation: and when that happens, it is evident there must be some error in the reckoning; to discover which, and where it lies, and also how to correct the reckoning, you may observe the following rules.

1st, If the ship sail near the meridian, or within 2 or $2\frac{1}{2}$ points thereof; then if the latitude by account disagrees with the latitude by observation, it is most likely that the error lies in the distance run; for it is plain, that in this case it will require a very sensible error in the course to make any considerable error in the difference of latitude, which cannot well happen if due care be taken at the helm, and proper allowances be made for the lee-way, variation, and currents. Consequently, if the course be pretty near the truth, and the error in the distance run regularly through the whole, we may, from the latitude obtained by observation, correct the distance and departure by account, by the following analogies, viz.

As the dfference of latitude by account
is to the true difference of latitude,
So is the departure by account
to the true departure,
And so is the direct distance by account
to the true direct distance.

The reason of this is plain: for let AB (N° 33.) denote the meridian of the ship at A, and suppose the ship sails upon the rhumb AE near the meridian, till by account she is found in C, and consequently her difference of latitude by account is AB; but by observation she is found in the parallel ED, and so her true difference of latitude is AD, her true distance AE, and her true departure DE; then, since the triangles ABC ADE are similar, it will be AB : AD : : BC : DE, and AB : AD : : AC : AE.

Example. Suppose a ship from the latitude of 45° 20′ north, after having sailed upon several courses near the meridian for 24 hours, her difference of latitude is computed to be upon the whole 95 miles southerly, and her departure 34 miles easterly; but by observation she is found to be in the latitude of 43° 10′ north, and consequently her true difference of latitude is 130 miles southerly: then for the true departure, it will be, As the difference of latitude by account 95 is to the true difference of latitude 130; so is the departure by account 34 to the true departure 46.52, and so is the distance by account 100.9 to the true distance 138.

2dly, If the courses are for the most part near the parallel of east and west, and the direct course be within $5\frac{1}{2}$ or 6 points of the meridian; then if the latitude by account differs from the observed latitude, it is most probable that the error lies in the course or distance, or perhaps both; for in this case it is evident, the departure by account will be very nearly true; and thence by the help of this, and the true difference of latitude, may the true course and direct distance be readily found by *Case* 4. *of Plane Sailing*.

Example. Suppose a ship from the latitude of 43° 50′ north, after having sailed upon several courses near the parallel of east and west, for the space of 24 hours, is found by dead reckoning to be in the latitude of 42° 45′ north, and to have made 160 miles of westing; but by a good observation the ship is found to be in the latitude of 42° 35′ north: Required the true course, and direct distance sailed.

With the true difference of latitude 75 miles, and departure 160 miles, we shall find (by *Case* 4. *of Plane Sailing*) the true course to be S. 64° 53′ W. and the direct distance 176.7 miles.

3dly, If the courses are for the most part near the middle of the quadrant, and the direct course within 2 and 6 points of the meridian; then the error may be either in the course or in the distance, or in both, which

which will cause an error both in the difference of latitude and departure; to correct which, having found the true difference of latitude by observation, with this, and the direct distance by dead reckoning, find a new departure (by *Case* 3. *of Plane Sailing*;) then half the sum of this departure, and that by dead reckoning, will be nearly equal to the true departure; and consequently with this, and the true difference of latitude, we may (by *Case* 4. *of Plane Sailing*) find the true course and distance.

Example. Suppose a ship from the latitude of 44° 38′ north, sails between south and east upon several courses, near the middle of the quadrant, for the space of 24 hours, and is then found by dead reckonings to be in the latitude of 42° 15′ north, and to have made of easting 136 miles; but by observation she is found to be in the latitude of 42° 04′ north: Required her true course and distance.

With the true distance of latitude 154 miles, and the direct distance by dead reckoning 197.4, you will find (by *Case* 3. *of Plane Sailing*) the new departure to be 123.4, and half the sum of this and the departure by dead reckoning will be 123.7 the true departure; then with this, and the true difference of latitude, you will find (by *Case* 4. *of Plane Sailing*), the true course to be S. 39° 00′ E. and the direct distance 198.2 miles.

7. In keeping a ship's reckoning at sea, the common method is to take from the log-board the several courses and distances sailed by the ship last 24 hours, and to transfer these together with the most remarkable occurrences into the log-book, into which also are inserted the courses corrected, and the difference of latitude and difference of longitude made good upon each; then the whole day's work being finished in the log-book, if the latitude by account agree with the latitude by observation, the ship's place will be truly determined; if not, then the reckoning must be corrected according to the preceding rules, and placed in the journal.

The form of the Log-book and Journal, together with an example of 2 days work, you have here subjoined.

Note, to express the days of the week, they commonly use the characters by which the sun and planets are expressed, *viz.* ☉ denotes *Sunday*, ☽ *Monday*, ♂ *Tuesday*, ☿ *Wednesday*, ♃ *Thursday*, ♀ *Friday*, and ♄ denotes *Saturday*.

§ 11. *The Form of the Log-Book, with the Manner of working Days Works at Sea.*

The Log-Book.

H.	K.	½K.	Courses.	Winds.	Observations and Accidents. ☽.— Day of —
					Fair weather, at
1					four this afternoon
2				North	I took my depar-
3					ture from the Li-
					zard; in the lati-
4					tude of 5° 00′
5	7		S W *b* S	N *b* E	north, it bearing
6	7				N N E, distance
					five leagues.
7	7	1			
8	7	1			
9	6				
10	6				
11	6		S S W	E *b* S	The gale increa-
12	6	1			sing and being un-
					der all our sails.
1	6	1			After three this
2	6	1	SW*b*W	NNE	morning, frequent
3	6	1			showers with thick
					weather till near
4	7				noon.
5	7	1			
6	8				
7	8				
8	8		S W	ENE	The variation I
9	8	1			reckon to be one
					point westerly.
10	9				
11	8	1	SW½W	NE*b*E	
12	8				

The Log-Book.

Courses Corrected.	Dist.	Diff. Lat. N.	Diff. Lat. S.	Diff. Long. E.	Diff. Long. W.
S SW	50		46.2		29.4
S *b*W	19		18.6		5.5
S W	49		29.7		45.5
S W*b*S	24.5		20.2		20.0
S W½S	25.5		19.5		24.6
			144.2		125.0

Hence the ship, by account, has come to the latitude of 47° 46′ north, and has differed her longitude 2° 5′ westerly; so this day I have made my way good S. 31° 31′ W. distance 157.4 miles.

At noon the Lizard bore from me N. 31° 31′ E. distance 157.4 miles; and having observed the latitude, I found it agreed with the latitude by account.

The

The Log-Book.

H.	K.	½K.	Courses.	Winds.	Observations and Accidents ♂— Day of——
1	2		SSW	W	This 24 hours,
2	1	1	Handed the main		strong gale of wind
3	1	1	and fore courses,		and variable.
4	1	1	lee-way 6 points.		
5	1	1			
6	1				
7	1				
8	1	1	The wind increa-		
9	1		sing, we tried a		
10	1		hull, lee-way 7		The variation I
11	1		points.		judge to be 1
12	1	1			point west.
1	2		SW*b*W	NW*b*W	
2	1	1	Set main-sail, lee-		
3	1		way 4½ points.		
4	1				
5	1				
6	1	1			
7	1				
8	4		S*b*E	SW*b*W	
9	4	1	Set fore-sail, lee-		
10	4	1	way 3 points.		
11	5				Lat. by observa-
12	4	1			tion, 47° 06' N.

The Log-Book.

Courses Correct.	Dist.	Diff. Lat. N.	Diff. Lat. S.	Diff. Long. E.	Diff. Long. W.
SE*b*E	32.5		17.8	37.7	
ESE	6		2.3	10.6	
S½E	9		8.9	1.3	
			29.0	49.6	

Hence the ship, by account, has come to the latitude of 47° 17' north, and has differed her longitude 49' easterly; consequently she has got 1° 16' to the westward of the Lizard, and has made her way good the last 24 hours 849° 08' E, distance 44.3 miles.

At noon the Lizard bore from me north 17° 7' east, distance 170.6 miles.

This day I had an observation, and found the latitude by account to disagree with the latitude by observation by 11 minutes, I being so much further to the southward than by dead reckoning, which by the third of the preceding rules I correct as in the Journal.

A Journal from the Lizard towards Jamaica in the ship Neptune, *J. M.* commander.

Week Days.	Months Years.	Month Days.	Winds.	Direct Course.	Dist. Miles	Latitude Correct.	Whole Diff. Long. made.	Bearing and Dist. from the Lizard.	Remarkable Observations and Accidents.
☽	——	——	N*b*E E*b*S NNE ENE NE*b*E	S 31, 31 W	157.4	47°, 46'	2°, 5' W	At noon the Lizard bore N. 31° 31' E. Dist. 157.4 miles.	Fair weather at four *P. M.* I took my departure from the Lizard, it bearing NNE distance 5 leagues.
♂	——	——	West NW*b*W SW*b*W	S 34, 01 E	8.2	47°, 06'	1°, 55' W	At noon the Lizard bore S. 17° 55' W. Dist. 183 miles.	Strong gales of wind and variable.

Inland NAVIGATION. See CANAL, and TRADE.

NAUMACHIA, in antiquity, a ſhew or ſpectacle among the ancient Romans, repreſenting a ſea-fight.

NAUMBURG, a town of Germany, in the circle of Upper Saxony, capital of the county of Saxe-Naumburg, ſituated on the river Sala, in E. Long. 11. 20. N. Lat. 51. 12.

NAUPACTUS, or NAUPACTUM, (anc. geogr.), the extreme or outmoſt town of the Ætolians, formerly belonging to the Locrians, but adjudged by Philip to the former: ſo called from the ſhipbuilding there carried on, and ſituated near Antirrhium on the Corinthian bay. *Naupactus*, the epithet. Now *Lepanto*, a port-town of Achaia or Livadia, on the north ſide of the gulf of that name. E. Long. 22. 20. N. Lat. 38. 0.

NAUPORTUS, or NAUPORTUM, (anc. geogr.), a town on a cognominal river, towards its ſource, in Pannonia Superior. The reaſon of the name, according to Pliny, is, that the ſhip Argo, after coming up the Danube, the Save, and the Laubach, was thence carried on mens ſhoulders over the Alps into the Adriatic. The river Nauportus riſes in the Alps, near Longaticum, at the diſtance of ſix miles from the town Nauportum; which was a colony of the Tauriſci, a people on the confines of Noricum. Now *Upper Laubach* in Carinthia, on the river Laubach. E. Long. 14. 40. N. Lat. 46. 28.

NAUSEA, or SICKNESS; a retching or propenſity and endeavour to vomit, ariſing from ſomething which irritates the ſtomach.

NAUTILUS, in zoology, a genus belonging to the order of vermes teſtacea. The ſhell conſiſts of one ſpiral valve, divided into ſeveral apartments by partitions. There are 17 ſpecies, chiefly diſtinguiſhed by particularities in their ſhells.

Bonani obſerves, that this genus of ſhell-fiſh is very well named from the Greek ναυτιλος, which ſignifies both "a ſhip," and "a ſailor;" for that the ſhells of all the nautili carry the appearance of a ſhip with a very high poop. Different authors, both ancient and modern, have called the nautilus by the names of *pompilus*, *nauplius*, *nauticus*, *ovum polypi*, *polypus teſtaceus;* and the French call it *le voilier.* It is by ſome imagined, that men firſt learned the art of navigation from this animal. See *Hiſtory of* NAVIGATION.

The moſt remarkable diviſion of the nautili is into the thin and thick-ſhelled kinds. The firſt is called *nautilus papyraceus;* and its ſhell is indeed no thicker than a piece of paper when out of the water. This ſpecies is not at all faſtened to its ſhell; but there is an opinion, as old as the days of Pliny, that this creature creeps out of its ſhell, and goes on ſhore to feed. When this ſpecies is to ſail, it expands two of its arms on high, and between theſe ſupports a membrane, which it throws out on this occaſion: this ſerves for its ſail, and the two other arms it hangs out of its ſhell, to ſerve occaſionally either as oars or as a ſteerage; but this laſt office is generally ſerved by the tail. When the ſea is calm, it is frequent to ſee numbers of theſe creatures diverting themſelves in this manner: but as ſoon as a ſtorm riſes, or any thing gives them diſturbance, they draw in their legs, and take in as much water as makes them ſpecifically heavier than that in which they float; and then they ſink to the bottom. When they riſe again, they void this water by a number of holes, of which their legs are full. The other nautilus, whoſe ſhell is thick, never quits that habitation. This ſhell is divided into 40 or more partitions, which grow ſmaller and ſmaller as they approach the extremity or centre of the ſhell: between every one of theſe cells and the adjoining ones there is a communication by means of a hole in the centre of every one of the partitions. Through this hole there runs a pipe of the whole length of the ſhell. It is ſuppoſed by many, that by means of this pipe the fiſh occaſionally paſſes from one cell to another; but this ſeems by no means probable, as the fiſh muſt undoubtedly be cruſhed to death by paſſing through it. It is much more likely that the fiſh always occupies the largeſt chamber in its ſhell; that is, it lives in the cavity between the mouth and the firſt partition, and that it never removes out of this; but that all the apparatus of cells, and a pipe of communication which we ſo much admire, ſerves only to admit occaſionally air or water into the ſhell, in ſuch proportion as may ſerve the creature in its intentions of ſwimming.

Some authors call this ſhell the *concha margaritifera:* but this can be only on account of the fine colour on its inſide, which is more beautiful than any other mother-of-pearl; for it has not been obſerved that this ſpecies of fiſh ever produced pearls. It muſt be obſerved, that the polypus is by no means to be confounded with the paper-ſhelled nautilus, notwithſtanding the great reſemblance in the arms and body of the incloſed fiſh; nor is the cornu ammonis, ſo frequently found foſſile, to be confounded with the thick-ſhelled nautilus, though the concamerations and general ſtructure of the ſhell are alike in both; for there are great and eſſential differences between all theſe genera.

NAVY, the fleet or ſhipping of a prince or ſtate. See MARINE.

The management of the Britiſh navy-royal under the lord high admiral of Great Britain, is entruſted to principal officers and commiſſioners of the navy, who hold their places by patent. The principal officers of the navy are four, viz. the treaſurer, whoſe buſineſs it is to receive money out of the exchequer, and to pay all the charges of the navy, by warrant from the principal officers: comptroller, who attends and controuls all payment of wages, is to know the rates of ſtores, to examine and audit all accounts, &c.: ſurveyor, who is to know the ſtates of all ſtores, and ſee wants ſupplied; to eſtimate repairs, charge boatſwains, &c. with what ſtores they receive, and at the end of each voyage to ſtate and audit accounts: clerk of the acts, whoſe buſineſs it is to record all orders, contracts, bills, warrants, &c.

The commiſſioners of the navy are five: the firſt executes that part of the comptroller's duty which relates to the comptrolling the victualler's accounts; the ſecond, another part of the ſaid comptroller's duty relating to the account of the ſtorekeepers of the yard; the third has the direction of the navy at the port of Portſmouth; the fourth has the ſame at Chatham; and the fifth at Plymouth. There are alſo other commiſſioners at large, the number more or

leſs

lefs according to the exigencies of public affairs; and fince the increafe of the royal navy, thefe have feveral clerks under them, with falaries allowed by the king.

The victualling of the royal navy hath formerly been undertaken by contract; but is now managed by commiffioners, who hold their office on Tower-hill, London. The navy-office is where the whole bufinefs concerning the navy is managed by the principal officers and commiffioners.

The royal navy of Great Britain is now in a very flourifhing ftate, having been diligently kept up in late reigns, as the natural ftrength of the kingdom. When it is complete, it is divided into three fquadrons, diftinguifhed by the colours of the flags carried by the refpective admirals belonging to the fame, viz. *red*, *white*, and *blue;* the principal commander of which bears the title of *admiral:* and each has under him a vice-admiral and a rear-admiral, who are likewife flag-officers.

Navy-*Exercife*. See Exercise.

Navy-*Difcipline* or *Regulations*. See Maritime *State*.

NAXIA, or Naxos, a confiderable ifland of the Archipelago, 25 miles in length, and 88 in circumference. The whole ifland is covered with orange, olive, lemon, cedar, citron, pomegranate, fig, and mulberry-trees; and there are a great many fprings and brooks. This ifland has no harbour; and yet they carry on a confiderable trade in barley, wine, figs, cotton, filk, flax, cheefe, falt, oxen, fheep, mules, and oil. They burn only oil of maftic, though olive-oil is exceeding cheap. It is inhabited both by Greeks and Latins, who live in great dread of the Turks: for when the meaneft of their fhips appear here, they always wear red caps like galley-flaves, and tremble before the loweft officer; but, as foon as they are gone, they put on their caps of velvet. The ladies are fo vain, that, when they return out of the country, they have 40 women in their train, half on foot and half on affes, one of whom carries a napkin or two, another a petticoat, another a pair of ftockings, and fo on; which is a very ridiculous fight to ftrangers. There are four archbifhops fees in this ifland, and a great many villages; but fo thin of people, that the whole ifland does not contain above 8000 inhabitants. The higheft mountain is *Zia*, which fignifies "the mountain of Jupiter." There are but few antiquities, except fome fmall remains of the temple of Bacchus. Some fay they have mines of gold and filver; however, there is one of emery, which is fo common here, and fo cheap, that the Englifh often ballaft their fhips therewith.

Naxos, or *Naxia*, a confiderable town, and capital of the ifle of Naxos, over-againft the ifle of Paros, with a caftle and two archbifhops fees, the one Greek and the other Latin. The greateft part of the inhabitants are Greeks. E. Long. 25. 51. N. Lat. 37. 8.

NAXUS (anc. geogr.), the moft remarkable of the Cyclades, 18 miles to the eaft of Delos; called *Strongyle*, then *Dia*, and *Dionyfias*. Some have called it *Sicily the Lefs*. Now called *Naxia*, *Nixia*, or *Naxos*. E. Long. 26. 5. N. Lat. 36. 30.

Naxus (anc. geogr.), a town of Crete, famous for its hones, called *Lapis Naxius*. Another of Sicily, built by the Chalcidian; fituate on the fouth fide of Mount Taurus, deftroyed by Dionyfius the tyrant; from whofe ruins Tauromenium, built by Timoleon, either arofe or was increafed, (Plutarch).

NAZARENES, in church-hiftory, a name originally given to all Chriftians in general, on account that Jefus Chrift was of the city of Nazareth; but afterwards reftrained to a fet of heretics, whofe religion confifted of a ftrange jumble of Judaifm and Chriftianity, obferving at the fame time the Mofaical law, and the rites of the Chriftian religion.

NAZARETH (anc. geogr.), a town of Galilee near mount Tabor, fituate on an eminence; the place of the annunciation or conception of our Saviour, and of his refidence till he entered on his public miniftry at 30 years of age.

NAZARITES, among the Jews, perfons who, either of themfelves, or by their parents, were dedicated to the obfervation of Nazaritefhip. They were of two forts; namely, fuch as were bound to this obfervance only for a fhort time, as a week or a month; or thofe who were bound to it all their lives. All that we find peculiar in the latter's way of life is, that they were to abftain from wine and all intoxicating liquors, and never to fhave or cut off the hair of their heads. The firft fort of Nazarites were, moreover, to avoid all defilement; and if they chanced to contract any pollution before the term was expired, they were obliged to begin afrefh. Women as well as men might bind themfelves to this vow.

NAZIANZEN. See Gregory *Nazianzen*.

NEALED, among feamen, is ufed when the founding is deep water clofe to the fhore; as alfo when the fhore is fandy, clayey, oozy, or foul and rocky ground.

NEALING, or rather Annealing, a term ufed for the preparing of feveral matters, by heating or baking them in the oven, or the like.

NEAPED. When a fhip wants water, fo that fhe cannot get out of the harbour, off the ground, or out of the dock, the feamen fay fhe is *neaped*, or *beneaped*.

NEAPOLIS (anc. geogr.), a city of the Higher Egypt, in the Nomos Panopolitanus, between Thebæ to the fouth, and Panopolis to the north, on the eaft fide of the Nile. Otherwife called *Caene*.—A fecond Neapolis of Babylonia, fituate near the Euphrates, on the fouth fide.—A third of Campania, an ancient town, and a colony from Cumæ, called at firft *Parthenope*, from the tomb of the firen of that name, (Velleius, Pliny, Strabo); accounted a Greek city, and a great ftickler for Greek ufages, (Livy, Tacitus). Its hot baths were in nothing inferior to thofe of Baiæ, according to Strabo: at two miles diftance from it ftands the monument of Virgil, held in religious veneration by learned pofterity. The Younger Pliny relates, that Virgil's birthday was more religioufly obferved by Silius Italicus than his own, efpecially at Naples, where he reforted to his tomb as to a temple. The city is wafhed by river Sebethus. Virgil feigns the nymph Sebethis to prefide over the ftream. Now *Naples*, capital of the kingdom of that name; E. Long. 15. 12. N. Lat. 41. 6.—A fourth, Neapolis of Caria, near the Meander, (Ptolemy).—A fifth, an inland town of Cyrenaica, fituate between Ptolemais and Arfinoe, (Ptolemy);

Neat ‖ Necessity.

lemy); and to be diftinguifhed from the Cænopolis, or Neapolis, on the eaft border of the fame province, (id.).—A fixth, of Ionia, (Strabo); which belonged firft to the Ephefians, but afterwards to the Samians, who exchanged Marathefium, a more diftant city, for a nearer.—A feventh, Neapolis of Macedonia Adjecta, fituate at the diftance of 12 miles to the eaft of Philippi, (Antonine).—An eighth, Neapolis of Pifidia, on the borders of Galatia, fituate between Amblada and Pappa, (Ptolemy).—A ninth, of Samaria, the ancient *Sichem*, which fee; fo called upon its reftoration by the Romans, (Coin, Pliny, Jofephus).—A tenth, of Sardinia, fituate on the fouth-weft fide of the ifland, 30 miles to the north of Metalla: now called *Neapoli*.—An eleventh, of the Regio Syrtica, called alfo *Leptis*.—A twelfth, of Zeugitana on the Mediterranean, to the eaft of Clypea, and fouth of the Promontorium Mercurii.

NEAT or NET *Weight*, the weight of a commodity alone, clear of the cafk, bag, cafe, or even filth. See NET.

NEBIO, or NEBBIO, a ruined city of Italy, on the north fide of the ifland of Corfica, with a bifhop's fee, whofe bifhop refides at San Florenzo, from which it is a mile diftant.

NEBO (anc. geogr.), a very high mountain, a part of the mountains Abarim, and their higheft top, whither Mofes was ordered to afcend to take a view of the land of Canaan, and there die. Situate in the land of Moab, over-againft Jericho: with a cognominal town at its foot (Ifaiah) belonging to the Reubenites, which afterwards returned to the Moabites; in Jerome's time defolate; eight miles to the fouth of Hefhbon.

NEBUCHADNEZZAR. See NABUCHADNEZZAR.

NEBULY, or NEBULEE, in heraldry, is when a coat is charged with feveral little figures, in form of words running within one another, or when the outline of a bordure, ordinary, &c. is indented or waved.

NECESSITY, whatever is done by a neceffary caufe, or a power that is irrefiftible; in which fenfe it is oppofed to freedom. See METAPHYSICS, n° 78—80.

NECESSITY, in law, as it implies a defect of will, excufes from the guilt of crimes. See CRIME.

Blackft. Comment.

Compulfion and inevitable *neceffity* are a conftraint upon the will, whereby a man is urged to do that which his judgment difapproves; and which, it is to be prefumed, his will (if left to itfelf) would reject. As punifhments are therefore only inflicted for the abufe of that free-will which God has given to man, it is highly juft and equitable that a man fhould be excufed for thofe acts which are done through unavoidable force and compulfion.

1. Of this nature, in the firft place, is the obligation of *civil fubjection*, whereby the inferior is conftrained by the fuperior to act contrary to what his own reafon and inclination would fuggeft: as when a legiflator eftablifhes iniquity by a law, and commands the fubject to do an act contrary to religion or found morality. How far this excufe will be admitted *in foro confcientiæ*, or whether the inferior in this cafe is not bound to obey the divine rather than the human law, it is not our bufinefs to decide; though, among the cafuifts, it is believed the queftion will hardly bear a doubt. But, however that may be, obedience to the laws in being is undoubtedly a fufficient extenuation of civil guilt before the municipal tribunal. The fheriff who burnt Latimer and Ridley in the bigotted days of queen Mary, was not liable to punifhment from Elizabeth for executing fo horrid an office; being juftified by the commands of that magiftracy which endeavoured to reftore Superftition, under the *holy* aufpices of its mercilefs fifter, Perfecution.

Neceffity.

As to perfons in private relations, the principal cafe where conftraint of a fuperior is allowed as an excufe for criminal mifconduct, is with regard to the matrimonial fubjection of the wife to her hufband: for neither a fon or a fervant are excufed for the commiffion of any crime, whether capital or therwife, by the command or coercion of the parent or mafter; though in fome cafes the command or authority of the hufband, either exprefs or implied, will privilege the wife from punifhment, even for capital offences. And therefore if a woman commit theft, burglary, or other civil offences againft the laws of fociety, by the coercion of her hufband, or even in his company, which the law conftrues a coercion, fhe is not guilty of any crime; being confidered as acting by compulfion, and not of her own will. Which doctrine is at leaft 1000 years old in this kingdom, being to be found among the laws of king Ina the Weft-Saxon. And it appears, that, among the northern nations on the continent, this privilege extended to any woman tranfgreffing in concert with a man, and to any fervant that committed a joint offence with a freeman: the male or freeman only was punifhed, the female or flave difmiffed; "*procul dubio quod alterum libertas, alterum neceffitas impelleret.*" But (befides that, in our law, which is a ftranger to flavery, no impunity is given to fervants, who are as much free agents as their mafters) even with regard to wives, this rule admits of an exception in crimes that are *mala in fe*, and prohibited by the law of nature; as murder, and the like: not only becaufe thefe are of a deeper dye; but alfo, fince in a ftate of nature no one is in fubjection to another, it would be unreafonable to fcreen an offender from the punifhment due to natural crimes, by the refinements and fubordinations of civil fociety. In treafon alfo, (the higheft crime which a member of fociety can, as fuch, be guilty of), no plea in coverture fhall excufe the wife; no prefumption of the hufband's coercion fhall extenuate her guilt: as well becaufe of the odioufnefs and dangerous confequence of the crime itfelf, as becaufe the hufband, having broken through the moft facred tie of focial community by rebellion againft the ftate, has no right to that obedience from a wife, which he himfelf as a fubject has forgotten to pay. In inferior mifdemefnors alfo, we may remark another exception, that a wife may be indicted and fet in the pillory *with* her hufband, for keeping a brothel: for this is an offence touching the domeftic œconomy or government of the houfe, in which the wife has a principal fhare; and is alfo fuch an offence as the law prefumes to be generally conducted by the intrigues of the female fex. And in all cafes where the wife offends alone, without the company

pany or coercion of her hufband, fhe is refponfible for her offence as much as any feme-fole.

2. Another fpecies of compulfion or neceffity is what our law calls *durefs per minas;* or threats and menaces, which induce a fear of death or other bodily harm, and which take away for that reafon the guilt of many crimes and mifdemefnors, at leaft before the human tribunal. But then that fear which compels a man to do an unwarrantable action ought to be juft and well-grounded; fuch, "*qui cadere poffit in virum conftantem, non timidum et meticulofum,*" as Bracton expreffes it, in the words of the civil law. Therefore, in time of war or rebellion, a man may be juftified in doing many treafonable acts by compulfion of the enemy or rebels, which would admit of no excufe in the time of peace. This, however, feems only, or at leaft principally, to hold as to pofitive crimes, fo created by the laws of fociety, and which therefore fociety may excufe; but not as to natural offences, fo declared by the law of God, wherein human magiftrates are only the executioners of divine punifhment. And therefore though a man be violently affaulted, and hath no other poffible means of efcaping death but by killing an innocent perfon, this fear and force fhall not acquit him of murder; for he ought rather to die himfelf than efcape by the murder of an innocent. But in fuch a cafe he is permitted to kill the affailant; for there the law of nature, and felf-defence its primary canon, have made him his own protector.

3. There is a third fpecies of neceffity, which may be diftinguifhed from the actual compulfion of external force or fear; being the refult of reafon and reflection, which act upon and conftrain a man's will, and oblige him to do an action which without fuch obligation would be criminal. And that is, when a man has his choice of two evils fet before him, and, being under a neceffity of choofing one, he choofes the leaft pernicious of the two. Here the will cannot be faid freely to exert itfelf, being rather paffive than active; or, if active, it is rather in rejecting the greater evil than in choofing the lefs. Of this fort is that neceffity, where a man by the commandment of the law is bound to arreft another for any capital offence, or to difperfe a riot, and refiftance is made to his authority: it is here juftifiable, and even neceffary, to beat, to wound, or perhaps to kill, the offenders, rather than permit the murderer to efcape, or the riot to continue. For the prefervation of the peace of the kingdom, and the apprehending of notorious malefactors, are of the utmoft confequence to the public; and therefore excufe the felony, which the killing would otherwife amount to.

4. There is yet another cafe of neceffity, which has occafioned great fpeculation among the writers upon general law; *viz.* whether a man in extreme want of food or clothing may juftify ftealing either, to relieve his prefent neceffities. And this both Grotius and Puffendorf, together with many other of the foreign jurifts, hold in the affirmative; maintaining by many ingenious, humane, and plaufible reafons, that in fuch cafes the community of goods, by a kind of tacit conceffion of fociety, is revived. And fome even of our lawyers have held the fame; though it feems to be an unwarranted doctrine, borrowed from the notions of fome civilians: at leaft it is now antiquated, the law of England admitting no fuch excufe at prefent. And this its doctrine is agreeable not only to the fentiments of many of the wifeft ancients, particularly Cicero, who holds, That *fuum cuique incommodum ferendum eft, potius quam de alterius commodis detrahendum;* but alfo to the Jewifh law, as certified by king Solomon himfelf: "If a thief fteal to fatisfy his foul when he is hungry, he fhall reftore fevenfold, and fhall give all the fubftance of his houfe:" which was the ordinary punifhment for theft in that kingdom. And this is founded upon the higheft reafon: for mens properties would be under a ftrange infecurity, if liable to be invaded according to the wants of others; of which wants no man can poffibly be an adequate judge, but the party himfelf who pleads them. In England efpecially, there would be a peculiar impropriety in admitting fo dubious an excufe: for by the laws fuch fufficient provifion is made for the poor by the power of the civil magiftrate, that it is impoffible that the moft needy ftranger fhould ever be reduced to the neceffity of thieving to fupport nature. The cafe of a ftranger is, by the way, the ftrongeft inftance put by baron Puffendorf, and whereon he builds his principal arguments: which, however they may hold upon the continent, where the parfimonious induftry of the natives orders every one to work or ftarve, yet muft lofe all their weight and efficacy in England, where charity is reduced to a fyftem, and interwoven in our very conftitution. Therefore our laws ought by no means to be taxed with being unmerciful, for denying this privilege to the neceffitous; efpecially when we confider, that the king, on the reprefentation of his minifters of juftice, hath a power to foften the law, and to extend mercy in cafes of peculiar hardfhip. An advantage which is wanting in many ftates, particularly thofe which are democratical: and thefe have in its ftead introduced and adopted, in the body of the law itfelf, a multitude of circumftances tending to alleviate its rigour. But the founders of our conftitution thought it better to veft in the crown the power of pardoning particular objects of compaffion, than to countenance and eftablifh theft by one general undiftinguifhing law.

NECHO, king of Egypt, began his reign 69 B.C. and was killed eight years after by Sabacon king of Ethiopia. Pfammiticus his fon fucceeded him, and was the father of Necho II. who reigned in the 616 B. C. This Necho II. is celebrated in hiftory for attempting, though in vain, to cut a canal from the Nile to the Arabian gulf. He fent the Phœnicians to fail round Africa by fea, defeated Jofias and the Babylonians, and gained many victories; but he was conquered in his turn by Nebuchadnezzar, who confined him within his ancient kingdom.

NECK, in anatomy, is that flender part fituated between the head and trunk of the body. See ANATOMY, n° 30.

NECROMANCY, or NEGROMANCY, a fpecies of divination performed by raifing the dead, and extorting anfwers from them. See DIVINATION.

NECTAR, among ancient poets, the drink of the fabulous deities of the heathens; in contradiftinction from their folid food, which was called *ambrofia.*

NECTARINE, a fruit differing in nothing from the common peach, of which it is a fpecies, than in having a fmoother rind and a firmer pulp. See PERSICA.

NECTARIUM, from *nectar*, the fabled "drink of

Nectarium. of the gods;" defined by Linnæus to be a part of the corolla, or apendage to the petals, appropriated for containing the honey, a ſpecies of vegetable ſalt under a fluid form, that oozes from the plant, and is the principal food of bees and other inſects.

Notwithſtanding this definition, which ſeems to conſider the nectarium as neceſſary a part of the corolla as the petals; it is certain that all flowers are not provided with this appendage, neither indeed is it eſſential to fructification.

Milne's Bot. Dict.

There is, beſides, a manifeſt impropriety in terming the nectarium a part of the corolla. Linnæus might, with equal propriety, have termed it a part or appendage of the ſtamina, calix, or pointal, as the appearance in queſtion is confined to no particular part of the flower, but is as various in point of ſituation as of form. The truth is, the term *nectarium* is exceedingly vague; and, if any determinate meaning can be affixed to it, is expreſſive of all the ſingularities which are obſerved in the different parts of flowers.

The tube, or lower part of flowers with one petal, Linnæus conſiders as a true nectarium, becauſe it is generally found to contain the ſweet liquor formerly mentioned. This liquor Pontedera compares to that called *amnios* in pregnant animals, which enters the fertile or impregnated ſeeds: but that this is not at leaſt its ſole uſe, is evident from this circumſtance, that the honey or liquor in queſtion is to be found in flowers where there are either no ſeeds, or thoſe, from the want of male organs, cannot be impregnated. Thus the male flowers of nettle and willow; the female flowers of ſea-ſide laurel, and black bryony; the male and female flowers of clutia, higgelaria, and butcher's broom, all abound with the honey or nectar alluded to.

Dr Vaillant was of opinion, that the nectarium was an eſſential part of the corolla; for which reaſon he diſtinguiſhed the ſingular appearances in fennel-flower and columbine, by the name of *petals:* the coloured leaves which are now termed the *petals*, he denominates the *flower-cup*.

That the nectarium, however, is frequently diſtinct from the petals, is evident, both from the well-known examples juſt mentioned, as likewiſe from the flowers of monkſhood, hellebore, iſopyrum, fennel-flower of Crete, barrenwort, graſs of Parnaſſus, chocolate-nut, cherleria, and ſauvageſia.

Theſe general obſervations being premiſed, we proceed to take a nearer and more particular view of the principal diverſities, both in form and ſituation, of this ſtriking appendage to the flower. 1. In many flowers the nectarium is ſhaped like a ſpur or horn; and that either in flowers of one petal, as valerian, water-milfoil (*urticularia*), butter-wort, and calves-ſnout; or in ſuch as have more than one, as lark-ſpur, violet, fumatory, balſam, and orchis. 2. In the following plants, the nectarium is properly a part of the corolla, as lying within the ſubſtance of the petals: ranunculus, lily, iris, crown-imperial, water-leaf, mouſe-tail, ananas or pine-apple, dog's-tooth violet, piperidge buſh, valliſneria, hermannia, uvularia, and ſwertia. 3. The nectarium is frequently placed in a ſeries or row within the petals, though entirely unconnected with their ſubſtance. In this ſituation it often reſembles a cup, as in narciſſus. A nectarium of this kind is ſaid by Linnæus to crown the corolla. The following are examples: daffodil, ſea-daffodil, campion, viſcous campion, ſwallow-wort, ſtapelia, cynanchum, nepenthes, cherleria, balſam-tree, African ſpiræa, witch-hazel, olax, and paſſion-flower. 4. In Indian creſs, buckler muſtard, Barbadoes cherry, and monotropa, the nectarium is ſituated upon or makes part of the calix. 5. The nectarium in baſtard flower-fence is ſeated upon the antheræ or tops of the ſtamina; whence the name *adenanthera*, or *glandular anthera*, which has been given to this genus of plants. In the following liſt it is placed upon the filaments: bean-caper, bay, fraxinella, marvel of Peru, bell-flower, lead-wort, roëlla, and commelina. 6. In hyacinth, flowering-ruſh, ſtock July-flower, and rocket, the nectarium is placed upon the ſeed-bud. 7. In honey-flower, orpine, buck-wheat, collinſonia, lathræa, navel-wort, mercury, clutia, kiggelaria, ſea-ſide laurel, and African ſpiræa, it is attached to the common receptacle. Laſtly, in ginger, nettle, dyer's weed, heart-ſeed, coſtus, turmeric, grewia, baſtard orpine, vanelloe, ſkrew-tree, and willow, the nectarium is of a very ſingular conſtruction, and cannot properly fall under any of the foregoing heads.

In diſcriminating the genera, the nectarium often furniſhes an eſſential character.

Plants which have the nectarium diſtinct from the petals, that is, not lodged within their ſubſtance, are affirmed by Linnæus to be generally poiſonous. The following are adduced as examples: monk's hood, hellebore, columbine, fennel-flower, graſs of Parnaſſus, barren-wort, oleander, marvel of Peru, bean-caper, ſucculent ſwallow-wort, fraxinella, and honey-flower.

Necydalis, Needle.

NECYDALIS, in zoology, a genus of inſects belonging to the order of coleoptera. The feelers are ſetaceous; the elytra are ſhorter and narrower than the wings; the tail is ſimple. There are 11 ſpecies, chiefly diſtinguiſhed by the ſize and figure of their elytra.

NEEDLE, a very common little inſtrument or utenſil, made of ſteel, pointed at one end, and pierced at the other, uſed in ſewing embroidery, tapeſtry, &c.

Needles make a very conſiderable article in commerce, though there is ſcarce any commodity cheaper, the conſumption of them being almoſt incredible. The ſizes are from n° 1. the largeſt, to n° 25. the ſmalleſt. In the manufacture of needles, German and Hungarian ſteel are of moſt repute.

In the making of them, the firſt thing is to paſs the ſteel through a coal-fire, and under a hammer, to bring it out of its ſquare figure into a cylindrical one. This done, it is drawn through a large hole of a wire-drawing iron, and returned into the fire, and drawn thro' a ſecond hole of the iron, ſmaller than the firſt; and thus ſucceſſively from hole to hole, till it has acquired the degree of fineneſs required for that ſpecies of needles; obſerving every time it is to be drawn, that it be greaſed over with lard, to render it more manageable. The ſteel thus reduced to a fine wire, is cut in pieces of the length of the needles intended. Theſe pieces are flatted at one end on the anvil, in order to form the head and eye: they are then put into the fire, to ſoften them farther; and thence taken out and pierced at each extreme of the flat part on the anvil, by force of a puncheon of well-tempered ſteel, and laid on a leaden block to bring out, with another puncheon,

Needle. cheon, the little piece of fteel remaining in the eye. The corners are then filed off the fquare of the heads, and a little cavity filed on each fide of the flat of the head; this done, the point is formed with a file, and the whole filed over: they are then laid to heat red-hot on a long narrow iron, crooked at one end, in a charcoal fire; and when taken out thence, are thrown into a bafon of cold water to harden. On this operation a good deal depends; too much heat burns them, and too little leaves them foft; the medium is learned by experience. When they are thus hardened, they are laid in an iron fhovel on a fire more or lefs brifk in proportion to the thicknefs of the needles; taking care to move them from time to time. This ferves to temper them, and take off their brittlenefs; great care here too muft be taken of the degree of heat. They are then ftraightened one after another with the hammer, the coldnefs of the water ufed in hardening them having twifted the greateft part of them.

The next procefs is the polifhing them. To do this, they take 12,000 or 15,000 needles, and range them in little heaps againft each other on a piece of new buckram fprinkled with emery-duft. The needles thus difpofed, emery-duft is thrown over them, which is again fprinkled with oil of olives; at laft the whole is made up into a roll, well bound at both ends. This roll is then laid on a polifhing table, and over it a thick plank loaden with ftones, which two men work backwards and forwards a day and a half, or two days, fucceffively; by which means, the roll thus continually agitated by the weight and motion of the plank over it, the needles withinfide being rubbed againft each other with oil and emery, are infenfibly polifhed. After polifhing, they are taken out, and the filth wafhed off them with hot water and foap: they are then wiped in hot bran, a little moiftened, placed with the needles in a round box, fufpended in the air by a cord, which is kept ftirring till the bran and needles be dry. The needles thus wiped in two or three different brans, are taken out and put in wooden veffels, to have the good feparated from thofe whofe points or eyes have been broke either in polifhing or wiping; the points are then all turned the fame way, and fmoothed with an emery-ftone turned with a wheel. This operation finifhes them, and there remains nothing but to make them into packets of 250 each.

Dipping Needle, or *Inclinatory Needle*, a magnetical needle, fo hung, as that, inftead of playing horizontally, and pointing out north and fouth, one end dips, or inclines to the horizon, and the other points to a certain degree of elevation above it.

The dipping-needle was invented in the year 1576, by one Robert Norman a compafs-maker at Wapping. The occafion of the difcovery, according to his own account was, that it being his cuftom to finifh and hang the needles of his compaffes before he touched them, he always found, that immediately after the touch, the north-point would bend or incline downward, under the horizon; infomuch that, to balance the needle again, he was always forced to put a piece of wax on the fouth-end as a counterpoife. The conftancy of this effect led him at length to obferve the precife quantity of the dip, or to meafure the greateft angle which the needle would make with the horizon; and this at London he found to be 71° 50′. In 1723 Mr Graham made a great many obfervations on the dipping-needle, and found the angle to be between 74 and 75 degrees. Mr Nairne, in 1772, found it to be fomewhat above 72°. It is not certain whether the dip varies, as well as the horizontal direction, in the fame place. The trifling difference between Mr Forman and Mr Nairne, would lead us to imagine that the dip was unalterable; but Mr Graham, who was a very accurate obferver, makes the difference more confiderable. It is certain, however, from a great number of experiments and obfervations, that the dip is variable in different latitudes, and that it increafes in going northwards. It appears from a table of obfervations made with the marine dipping-needle in a voyage towards the north pole, in 1773, that in lat. 60. 18. the dip was 75°; and in lat 70. 45. it was 77° 52′; in lat. 80. 12. it was 81° 52′; and in lat. 80. 27. it was 82° $2\frac{1}{2}$′,

Several authors have endeavoured to apply this difcovery of the dip to the finding of the latitude; and Mr Bond attempted to apply it to the finding of the longitude alfo; but for want of obfervations and experiments, he could not make any progrefs. The affair was farther profecuted by Mr Whifton, who publifhed a treatife on the longitude, and for fome time imagined it was poffible to find it exactly by means of the dip of the needle; yet he at laft defpaired of it, for the following reafons. 1. The weaknefs of the magnetic power. 2. The concuffion of the fhip, which he found it exceeding difficult to avoid fo much as was neceffary for the accuracy of the experiments. 3. The principal objection was an irregularity in the motions of all magnetic needles, both horizontal and dipping, by which they, within the compafs of about a degree, vary uncertainly backward and forward; even fometimes, in a few hours time, without any evident caufe. For a particular account of thefe variations both of the horizontal and dipping needle, fee the article Variation.

Mr Nairne, an ingenious inftrument-maker in London, made a dipping-needle in 1772 for the board of longitude, which was ufed in the voyage towards the north-pole. This is reprefented Plate CCIV. fig. 1. The needle AA is 12 inches long, and its axis, the ends BB of which are made of gold alloyed with copper, refts on friction-wheels CCCC, of four inches diameter, each end on two friction-wheels; which wheels are balanced with great care. The ends of the axes of the friction-wheels, are likewife of gold alloyed with copper, and moved in fmall holes made in bell-metal; and oppofite to the ends of the axes of the needle, and the friction-wheels, are flat agates, fet in at DDD, finely polifhed. The magnetic needle vibrates within a circle of bell-metal, EEE, divided into degrees and half degrees; and a line, paffing through the middle of the needle to the ends, points to the divifions. The needle of this inftrument was balanced, before it was made magnetical; but by means of a crofs, the ends of which are FFFF, (contrived by the reverend Mr Mitchell) fixed on the axis of the needle, on the arms of which are cut very fine fcrews to receive fmall buttons, that may be fcrewed nearer or farther from the axis, the needle may be adjufted both ways to a great nicety, after being made magnetical, by reverfing the poles, and changing the fides of the needle. GG are two levels, by which the line of o degrees of the inftrument

ſtrument is ſet horizontal, by means of the four adjuſting ſcrews LLLL; H is the perpendicular axis, by which the inſtrument may be turned, that the divided face of the circle may front the eaſt or weſt; to this axis is fixed an index I, which points to an oppoſite line on the horizontal plate K when the inſtrument is turned half round; MMMM are ſcrews which hold the glaſs-cover to keep the needle from being diſturbed by the wind. When this needle is conſtructed for ſea, it is ſuſpended by an univerſal joint on a triangular ſtand, and adjuſted vertically by a plumb-line and button above the divided circle and the dovetail work at the upper 90; and the diviſions on the circle are adjuſted ſo as to be perpendicular to the horizon by the ſame plumb-line, and an adjoining ſcrew; and when it is adjuſted, a pointer annexed to a ſcrew, which ſerves to move the divided circle, is fixed at the loweſt 90. Whenever the inſtrument is uſed to find the dip, it muſt be ſo placed that the needle may vibrate exactly in the magnetic meridian.

Magnetical NEEDLE, in navigation, a needle touched with a loadſtone, and ſuſtained on a pivot or centre; on which playing at liberty, it directs itſelf to certain points in or under the horizon; whence the magnetical needle is of two kinds, viz. horizontal and inclinatory. See the article MAGNET.

Horizontal needles are thoſe equally balanced on each ſide the pivot that ſuſtains them; and which, playing horizontally with their two extremes, point out the north and ſouth points of the horizon. For their application and uſe, ſee the article COMPASS.

In the conſtruction of the horizontal needle, a piece of pure ſteel is provided; of a length not exceeding ſix inches, leſt its weight ſhould impede its volubility; very thin, to take its verticity the better; and not pierced with any holes, or the like, for ornament ſake, which prevent the equable diffuſion of the magnetic virtue. A perforation is then made in the middle of its length, and a braſs-cap or head ſoldered on, whoſe inner cavity is conical, ſo as to play freely on a ſtyle or pivot headed with a fine ſteel point. The north point of the needle in our hemiſphere is made a little lighter than the ſouthern; the touch always deſtroying the balance, if well adjuſted before, and rendering the north end heavier than the ſouth, and thus occaſioning the needle to dip.

The method of giving the needle its verticity or directive faculty, has been ſhewn already under the article MAGNET; but if, after touching, the needle be out of its equilibrium, ſomething muſt be filed off from the heavier ſide, till it balance evenly.

Needles in ſea-compaſſes are uſually made of a rhomboidal or oblong form: we have given their ſtructure already under the article COMPASS.

The needle is not found to point preciſely to the north, except in very few places; but deviates from it more or leſs in different places, and that too at different times; which deviation is called its *declination* or *variation from the meridian*. See the article VARIATION.

NEEDLE-*Fiſh*. See SYNGNATHUS.

NEEDLES, in geography, two capes or headlands at the weſt end of the Iſle of Wight, which it is is very difficult to paſs on account of the ſands and rocks.

NEFASTI DIES, in Roman antiquity, an appellation given to thoſe days wherein it was not allowed to adminiſter juſtice, uſually marked in the kalendar by N. or N. P. *i. e. nefaſtus prima*.

NEGAPATAN, a town of Aſia, in the peninſula on this ſide the Ganges, and on the coaſt of Coromandel. It was firſt a colony of the Portugueſe, but was taken from them by the Dutch. The factory purchaſe very little beſides tobacco and long linen cloths; however, the Dutch have thought proper to erect a ſort here. It is ſituated in E. Long. 79. 10. N. Lat. 11. 15.

NEGATION, in logic, an act of the mind affirming one thing to be different from another; as that the ſoul is not matter. See LOGIC.

NEGATIVE, in general, ſomething that implies a negation: thus we ſay, negative quantities, negative powers, negative ſigns, &c.

NEGATIVE *Electricity*. See the article ELECTRICITY *paſſim*. See alſo POSITIVE *Electricity*.

NEGOMBO, a ſea-port town of Aſia, on the weſt coaſt of Ceylon. It has a ſort built by the Portugueſe, which was taken from them by the Dutch in 1640. E. Long. 80. 25. N. Lat. 17. 0.

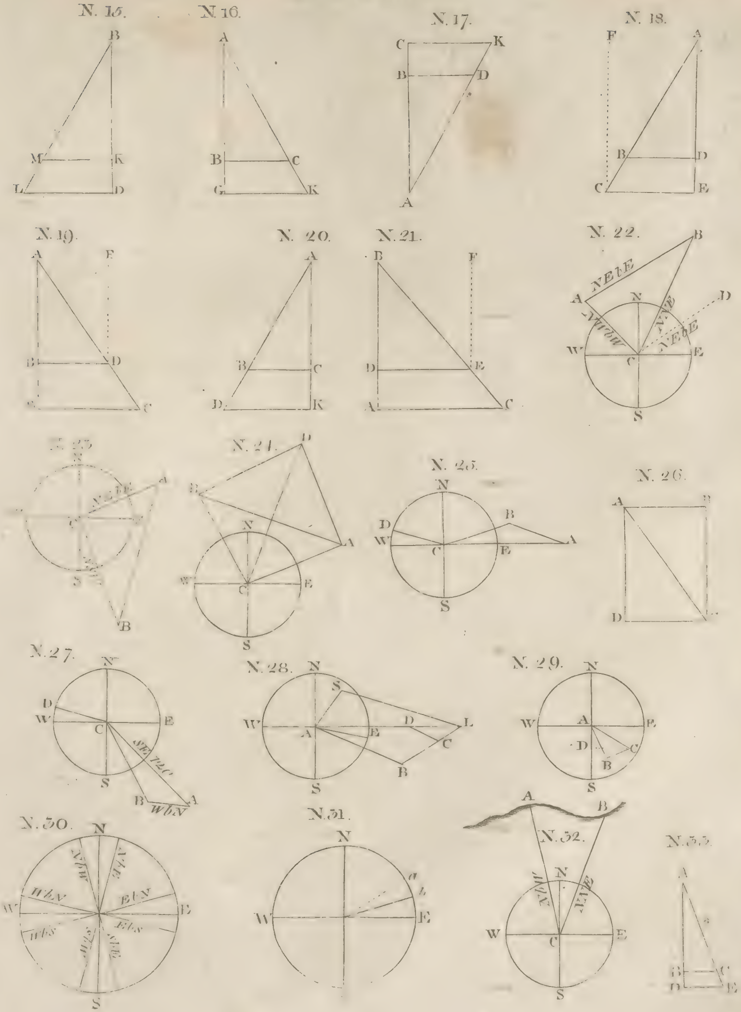
NEGRIL POINT, the moſt weſterly promontory of the iſland of Jamaica.

NEGROES, properly the inhabitants of Nigritia or Negroland in Africa, called alſo *Blacks* and *Moors*; but this name is now given to all the *Blacks*.

The origin of the Negroes, and the cauſe of this remarkable difference from the reſt of the human ſpecies, has much perplexed the naturaliſts. Mr Boyle has obſerved, that it cannot be produced by the heat of the climate: for though the heat of the ſun may darken the colour of the ſkin, yet experience does not ſhow that it is ſufficient to produce a new blackneſs like that of the Negroes.

In Africa itſelf, many nations of Ethiopia are not black; nor were there any blacks originally in the Weſt Indies. In many parts of Aſia, under the ſame parallel with the African region inhabited by the blacks, the people are but tawny. He adds, that there are Negroes in Africa beyond the ſouthern tropic; and that a river ſometimes parts nations, one of which is black, and the other only tawny. Dr Barriere alleges, that the gall of Negroes is black, and being mixed with their blood is depoſited between the ſkin and ſcarf-ſkin. However, Dr Mitchel of Virginia, in the Philoſophical Tranſactions n° 476, has endeavoured by many learned arguments to prove, that the influence of the ſun in hot countries, and the manner of life of their inhabitants, are the remote cauſes of the colour of the Negroes, Indians, &c. Se AMERICA, n° 48—51. and COLOUR *of the Human Species*.

Negroes are brought from Guinea, and other coaſts of Africa, and ſent to the colonies in America, to cultivate tobacco, ſugar, indigo, &c. and in Mexico and Peru to dig in the mines; and this commerce, however indefenſible on the foot of religion or humanity, is now carried on by all the nations that have ſettlements in the Weſt Indies. Thoſe Negroes make the beſt ſlaves who are brought from Angola, Senegal, Cape Verd, the river Gambia, the kingdoms of Joloffes, &c. There are various ways of procuring them: ſome, to avoid famine, ſell themſelves, their


N. 15.
N. 16.
N. 17.
N. 18.
N. 19.
N. 20.
N. 21.
N. 22.
NEbE
N. 24.
N. 25.
N. 26.
N. 27.
SE 72 C
WbN
N. 28.
N. 29.
N. 30.
WbN
EbN
N. 31.
N. 32.

Negroland. their wives and children, to their princes or other great men; others are made prifoners of war; and great numbers are feized in excurfions made for that very purpofe by the petty princes into one another's territories, in which it is ufual to fweep away all, without diftinction of age or fex.

NEGROLAND, or NIGRITIA, a country of Africa, lying next to Guinea towards the north, and extending from 18° of weft to 150° of eaft longitude, and from 10° to 20° of north latitude. On the north it is bounded by Zaara or the Defart; on the eaft, by countries unknown; on the fouth, by Guinea; and on the weft, by the Atlantic Ocean; and is watered by the great river Niger or Senegal, which runs through it from eaft to weft. The Europeans have fettlements on the coafts of this country, efpecially near the mouths of the Niger and Gambia, which laft is fuppofed to be a branch of the former. A great many nations inhabit the banks of the rivers; fome Pagans, fome Mohammedans, of different languages, and independent of one another. The country is fruitful, efpecially along the rivers; abounding in rice, Guinea grain, and Indian corn, where it is cultivated; and with cocoa-nuts, plantains, pulfe, palm-trees, and tropical fruits; nor is it deftitute of cattle, and a variety of other animals, particularly fuch as abound in Guinea.

Negroland is fertilized by the overflowing of its rivers the Senegal and Gambia, as Egypt is by the Nile. It hath not yet been afcertained whether the Gambia is a branch of the Senegal or not. As far as the Europeans have penetrated up the country, they appear to be diftinct; and the Mundingo Negroes report that the Gambia has a different origin. The entrance into the Niger or Senegal river is narrow and fomewhat difficult, by reafon of its immoveable bar and fandy fhoals, as well as the feveral iflands at the mouth of it, and the feveral canals and marfhes that clog it: but after failing up eight or ten leagues, it is found broad and deep, and fit to carry large veffels; and, excepting about five or fix leagues on each fide above the mouth, which is fandy and barren ground, the banks are covered with ftately trees and villages, and the country in general is fertile and well watered; for, like the Nile, this river overflows its banks for many leagues, and enriches the land to a great degree, though, for want of fkill, the inhabitants do not reap the advantages which they might obtain from its fertility. The people on both fides of the river live as near to it as they can, and feed great herds of cattle, fowing large and fmall millet, the former of which is called by us *Turkey wheat*, in great quantities, and with great increafe. If the river fails of overflowing at its ufual feafon, a great fcarcity, if not a downright famine, never fails to enfue in the adjacent country; and, even when it overflows regularly, it breeds fuch vaft flights of grafshoppers and infects, as quite darken the air, and frequently eat up all the product of the earth: in which cafe the only remedy the people have is to kill thofe infects and eat them; which they do either by pounding in leathern bags, and then boiling them in milk, or, which is reckoned the more delicious method, by frying or broiling them over a light blaze, in a frying-pan full of holes. Thus the legs and wings of the infects are burnt off, and the reft of the body is fufficiently roafted to be eaten as a dainty, which they look upon to be very wholefome and nourifhing. Negroland ‖ Negropont.

To the eaft, north-eaft, and fouth-eaft of the ifland of Senegal, the country, as far as it is known, is over-run with woods and marfhes; the Senegal, Gambia, and Sherbro, which are looked upon by fome as branches of one immenfe river, paffing through it in their way to the Atlantic Ocean. During the rainy months, which begin in July, and continue to October, they lay the whole country under water; and indeed the fudden rife of thefe rivers is incredible to fuch as are not acquainted with the violent rains that fall between the tropics. At Galam, 900 miles from the mouth of the Senegal, the waters rife 150 feet perpendicular from the bed of the river. At the ifland of Senegal, the river rifes gradually, during the rainy feafon, above 20 feet perpendicular over part of that flat coaft; which of itfelf fo frefhens the water, that fhips lying at anchor, at the diftance of three leagues from its mouth, generally make ufe of it, and fill their water there for their voyage home. When the rains are at an end, which ufually happens in October, the intenfe heat of the fun foon dries up thofe ftagnating waters which lie on the higher parts, and the remainder from lakes and marfhes, in which are found all forts of dead animals. At laft, thofe too are quite dried up; and then the effluvia that arife are almoft quite infupportable. At this feafon the winds blow fo hot from the land, that they may be compared to the heat proceeding from the mouth of an oven, and they bring with them an intolerable fmell. The wolves, tigers, lions, and other wild beafts, then refort to the river, keeping their body under water, and only their fnout above it for the fake of breathing. The birds foar to an immenfe height in the air, and fly a vaft way over the fea, where they continue till the wind changes, and comes from the weft. See SENEGAL, GUINEA, GOLD-*Coaft*, and SLAVE-*Coaft*.

NEGROMANCY. See NECROMANCY.

NEGROPONT, anciently *Eubœa*, an ifland of the Archipelago, ftretching along the eaftern coaft of Achaia or Livadia, from which it is feparated by a narrow channel called the *Euripus*. This ftrait is fo narrow, that the ifland is joined to the continent by a bridge thrown over it; and, here it is thought, there was formerly an ifthmus. The irregulary of the tides in the Euripus hath from the remoteft antiquity been very remarkable, and this irregularity is found to be connected with the age of the moon. From the three laft days of the old moon to the eighth day of the new moon, and from the 14th to the 20th day inclufive, they are regular; but on the other days they are irregular, flowing 12, 13, or 14 times in the fpace of 24 hours, and ebbing as often. The ifland is 90 miles long and 25 broad in the wideft part; and produces corn, oil, fruit, and cattle, in great abundance. The only place in the ifland worth notice is the capital, which is alfo called *Negropont*; and which is walled, and contains about 15,000 inhabitants; but the Chriftians are faid to be much more numerous than the Turks. The captain bafhaw, or admiral of Turkey, who is alfo governor of the city, the ifland, and the adjacent continent of Greece, refides here; and the harbour, which is very fafe and fpacious, is feldom

without a fleet of galleys, ready to be put to sea againſt the pirates and the Malteſe. A part of the bridge between the city and the coaſt of Greece, conſiſts of a drawbridge no longer than juſt to let a galley paſs through.

NEHEMIAH, a canonical book of the Old Teſtament, ſo called from the name of its author. Nehemiah was born in Babylon during the captivity, and ſucceeded Ezra in the government of Judah and Jeruſalem. He was a Jew, and was promoted to the office of cup-bearer to Artaxerxes Longimanus king of Perſia; when the opportunities he had of being daily in the king's preſence, together with the favour of Eſther the queen, procured him the favour of being authoriſed to repair and fortify the city of Jeruſalem in the ſame manner as it was before its deſtruction by the Babylonians. On his going to Jeruſalem, he finiſhed the rebuilding of the walls in 52 days, and dedicated the gates of the city with great ſolemnity. He then reformed ſome abuſes which had crept in among his countrymen, particularly the extortion of the uſurers, by which the poor were ſo oppreſſed as to be forced to ſell their lands and children for ſupport: after which he returned to Perſia, and came back again with a new commiſſion, by virtue of which he regulated every thing relating both to the ſtate and religion of the Jews. The hiſtory of theſe tranſactions is the ſubject of this book.

NEISSE, a handſome town of Sileſia in Germany, and the reſidence of the biſhop of Breſlaw, who has a magnificent palace here. The air is very wholeſome, and proviſions are cheap; the inhabitants carry on a great trade in wine and linen. This place ſuffered greatly by an inundation and fire in 1729. It was taken by the Pruſſians in 1741, who augmented the fortifications after the peace in 1742, and built a citadel to which they gave the name of *Pruſſia*. It is ſeated on a river of the ſame name; in E. long. 17. 35. N. lat. 50. 32.

NELSON (Robert), a learned and pious Engliſh gentleman, was the ſon of Mr John Nelſon a conſiderable Turkey merchant, and was born in June 1656. He had the firſt part of his education at St Paul's ſchool, London; but the principal part was under a private tutor in his mother's houſe, after which he ſtudied at Trinity College, Cambridge. In 1680 he was choſen a fellow of the Royal Society; being probably inclined to receive that honour out of reſpect to his friend and ſchool-fellow Dr Edmund Halley, for whom he had a particular regard, and in whoſe company he ſet out on his travels abroad the December following. In the road to Paris, they ſaw the remarkable comet which gave riſe to the cometical aſtronomy by Sir Iſaac Newton; and our author, apparently by the advantage of his fellow-traveller's inſtructions, ſent a deſcription of it to Dr, afterwards archbiſhop, Tillotſon, by whom he was very much eſteemed. From Paris he went with his fellow-traveller to Rome, where he fell into the acquaintance of Lady Theophila Lucy, widow of Sir Kingſmill Lucy of Broxburne in Hertfordſhire, bart. and ſecond daughter of George earl of Berkeley, who ſoon diſcovered a ſtrong paſſion for him: this concluded in marriage, after his arrival in England in 1682. But it was ſome time before ſhe confeſſed to Mr Nelſon the change of her religion; which was owing to her converſations at Rome with cardinal Philip Howard, who was grandſon of the earl of Arundel, the collector of the Arundelian marbles, &c. and had been raiſed to the purple by pope Clement X. in May 1675. Nor was this important alteration of her religious ſentiments confined to her own mind, but involved in it her daughter by her firſt huſband, whom ſhe drew over to her new religion; and her zeal for it prompted her even to engage in the public controverſy then depending. She is the ſuppoſed authoreſs of a piece written in 1686, 4to, under the title of, "A diſcourſe concerning a judge of controverſy in matters of religion, ſhewing the neceſſity of ſuch a judge."

This misfortune touched her huſband very nearly. He employed not only his own pen, but thoſe of his friends Dr Tillotſon and Dr Hickes, to recover her: but all proved ineffectual; and ſhe continued in the communion of the church of Rome till her death. She was a perſon of fine ſenſe and underſtanding. Dr Tillotſon particularly laments her caſe on that account; and even ſeems not to be entirely free from all apprehenſions of the influence ſhe might have upon her huſband in this important affair. But Mr Nelſon's religion was too much the reſult of his learning and reaſon to be ſhaken by his love, which was equally ſteady and inviolable. Her change of religion made no change in his affections for her; and when ſhe relapſed into ſuch a bad ſtate of health as obliged her to go and drink the waters at Aix, he attended her thither in 1688: and not liking the proſpect of the public affairs at home, he proceeded to make a ſecond trip to Italy, taking his lady, together with her ſon and daughter by her former huſband, along with him. He returned through Germany to the Hague, where he ſtaid ſome time with lord Durſley, who was married to his wife's ſiſter.

From the Hague he arrived in England, in the latter end of 1691; where, being averſe to the Revolution, he declared himſelf a nonjuror, and left the communion of the church of England. In this laſt point he had conſulted Dr Tillotſon, and followed his opinion, who thought it no better than a trick, deteſtable in any thing, and eſpecially in religion, to join in prayers where there was any petition which was held to be ſinful. Thus, notwithſtanding their difference of opinion in this caſe, the friendſhip between them remained the ſame; and the good archbiſhop expired in his friend's arms in 1694.

Our author's new character unavoidably threw him into ſome new connections. Among theſe we find mentioned particularly Mr Kettlewell, who had reſigned his living at Coleſhill in Warwickſhire on account of the new oaths, and afterwards reſided in London. This pious and learned divine alſo agreed with him in leaving the communion of the eſtabliſhed church; yet at the ſame time perſuaded him to engage in the general ſervice of piety and devotion; obſerving to him, that he was very able to compoſe excellent books of that kind, which would be apt to do more good as coming from a layman. This addreſs correſponded with the truly catholic ſpirit of our author; who accordingly publiſhed many works of piety, which are deſervedly eſteemed.

At the ſame time, he engaged zealouſly in every public

public scheme for the honour and interest, as well as for propagating the faith, and promoting the practice of true Christianity, both at home and abroad; severa proposals for building, repairing, and endowing churches, and charity-schools particularly.

Upon the death of Dr William Lloyd, the deprived bishop of Norwich, in the end of the year 1709, he returned to the communion of the church of England. Dr Lloyd was the last surviving of the deprived bishops by the Revolution, except Dr Kenn, by whose advice Mr Nelson was determined in this point. Mr Nelson's tutor, Dr George Bull, bishop of St David's, dying before the expiration of this year, he was easily prevailed upon by that prelate's son, to draw up an account of his father's life and writings, as he had maintained a long and intimate friendship with his Lordship, which gave him an opportunity of being acquainted with his solid and substantial worth. The life was published in 1713; and, as our author had long before laboured under a constitutional weakness, which had brought on an asthma and dropsy in the breast, the distemper grew to such a height soon after the publication of that work, that, for the benefit of the air, he retired at length to Kensington, where he expired on the 16th of January 1714-15. He left his whole estate to pious and charitable uses; particularly to charity-schools.

NEMAUSUS, or NEMAUSUM, (anc. geog.) the capital of the Arecomici in Gallia Narbonensis; a colony, (Coin), with the surname *Augusta*, (Inscription). In it stands a Roman amphitheatre, which is still almost entire. Now *Nismes* in Languedoc.

NEMEA, (Strabo, Livy); a river of Achaia, running between Sicyon and Corinth, the common boundary of both territories, and falling into the Corinthian bay.

NEMEA, (anc. geog.), situated between Cleonæ and Philus in Argolis; whether town, district, or other thing, uncertain: there a grove stood in which the Argives celebrated the Nemean games, and there happened all the fabulous circumstances of the Nemean lion. The district Nemea is called *Bembinadia*, (Pliny); a village, *Bembina*, standing near Nemea, (Strabo). Stephanus places Nemea in Elis; though not in, but on, the borders of Elis; Pliny, erroneously, in Arcadia. In the adjoining mountain is still shewn the den of the lion, distant 15 stadia from the place *Nemea*, (Pausanias); in which stands a considerable temple of Jupiter Nemæus and Cleonæus, from the vicinity of these two places. This place gave name to the Nemæan games, celebrated every third year.

NEMEAN GAMES, so called from Nemea, a village between the cities of Cleonæ and Philus, where they were celebrated every third year. The exercises were chariot-races, and all the parts of the Pentathlum. These games were instituted in memory of Opheltes or Archemorus, the son of Euphetes and Creusa, and who was nursed by Hypsipele; who leaving him in a meadow while she went to shew the besiegers of Thebes a fountain, at her return found him dead, and a serpent twined about his neck: whence the fountain, before called *Langia*, was named *Archemorus;* and the captains, to comfort Hypsipyle, instituted these games. Others ascribe their institution to Hercules, after his victory over the Nemean lion. Others allow, that they were instituted first in honour of Archemorus; but intermitted, and revived again by Hercules. The victors were crowned with parsley, an herb used at funerals, and feigned to have sprung from Archemorus's blood.

NEMESIANUS (Aurelius Olympius), a Latin poet, born at Carthage, who wrote a poem on the chace, intitled *Cynegeticon*, and four eclogues, which are still extant. This poet lived under the reign of Carus and his sons Carinus and Numerianus, about the year 281. People were so fond of his poem in the eighth and ninth centuries, that young men were obliged to read it in the public schools.

NEMESIS, in Pagan worship, the daughter of Jupiter and Necessity, or, according to others, of Oceanus and Nox, had the care of revenging the crimes which human justice left unpunished. She was also called *Adrastæa*, because Adrastus king of Argos first raised an altar to her; and *Rhamnusia*, from her having a magnificent temple at Rhamnus in Attica. She had likewise a temple at Rome in the Capitol. She is represented with a stern countenance, holding a whip in one hand, and a pair of scales in the other.

NEMINE CONTRADICENTE, "none contradicting it;" a term chiefly used in parliament when any thing is carried without opposition.

NEMOURS, a town of the Isle of France in the Gatinois, with the title of a duchy. It is seated on the river Loing, in E. long. 2. 45. N. lat. 48. 15.

NENIA, or NÆNIA, in the ancient poetry, a kind of funeral song sung to the music of flutes at the obsequies of the dead. Authors represent them as sorry compositions, sung by hired women-mourners called *Præficæ*. The first rise of these Nenia is ascribed to the physicians. In the heathen antiquity the goddess of tears and funerals was called *Nenia;* whom some suppose to have given that name to the funeral song, and others to have taken her name from it.

NEOMAGUS, (Ptolemy); NOVIOMAGUS, (Antonine); a town of the Regni in Britain: now thought to be Guildford in Surry, (Lhuyd); or Croydon, (Talbot). But Camden takes it to be Woodcote, two miles to the south of Croydon; where traces of an ancient town are still to be seen.

NEOMAGUS, (Ptolemy;) *Noviomagus*, (Antonine;) a town of the Triviri on the Moselle. Now *Numagen*, 14 miles east, below Triers.

NEOMAGUS, (Ptolemy;) *Noviomagus Lexoviorum*, (Antonine;) a town of Gallia Celtica. Now *Lisieux*, in Normandy.

NEOMAGUS, (Ptolemy;) *Noviomagus Nemetum*, (Antonine). Now *Spire*, a city of the Palatinate, on the left or west side of the Rhine.

NEOMAGUS, (Ptolemy); a town of Gallia Narbonensis, on the confines of the Tricastini. Now *Nyons* in Dauphiné.

NEOMENIA, or NOUMENIA, a festival of the ancient Greeks, at the beginning of every lunar month, which, as the name imports, was observed upon the day of the new moon, in honour of all the gods, but especially Apollo, who was called *Neomenios*, because the sun is the fountain of light, and whatever distinction of times and seasons may be taken from other planets, yet they are all owing to him as the original of those borrowed rays by which they shine.

The games and public entertainments at thefe feftivals were made by the rich, to whofe tables the poor flocked in great numbers. The Athenians at thefe times offered folemn prayers and facrifices for the profperity of their country during the enfuing month. See GAMES.

The Jews had alfo their neomenia, or feaft of the new moon, on which peculiar facrifices were appointed; and on this day they had a fort of family entertainment and rejoicing. The moft celebrated neomenia of all others was that at the beginning of the civil year, or firft day of the month Tifri, on which no fervile labour was performed: they then offered particular burnt-facrifices, and founded the trumpets of the temple. The modern Jews keep the neomenia only as a feaft of devotion, which any one may obferve or not as he pleafes.

NEOPHYTES, "new plants;" a name given by the ancient Chriftians, to thofe heathens who had newly embraced the faith; fuch perfons being confidered as regenerated, or born anew by baptifm. The term *neophytes* has been alfo ufed for new priefts, or thofe juft admitted into orders, and fometimes for the novices in monafteries. It is ftill applied to the converts made by the miffionaries among the infidels.

NEPA, in zoology, a genus of infects belonging to the order of hemiptera. The roftrum is inflected; the antennæ are fhorter than the thorax; and the hind-feet are hairy and fitted for fwimming. There are feven fpecies.

NEPER, or NAPIER (John), baron of Merchifton in Scotland, whofe high attainments in many branches of ufeful literature render his memory valuable, was born in 1550. He had a peculiar turn to mathematical inveftigations and ufeful inventions: among the latter may be ranked that inftrument called *Neper's Rods* or *Bones*, to facilitate the multiplication and divifion of large numbers; and his invention of logarithms have fpread his fame throughout the world. This difcovery was contained in his *Canon mirabilis Logarithmorum*, dedicated to prince Charles, and publifhed in 1614. In his *Rabdologia*, publifhed in 1616, he mentions another fpecies of thofe numbers; when, finding his health declining, he engaged Mr Briggs to profecute that ufeful laborious fcheme. Befides his abilities in thefe calculations, he is faid to have wrote an *Expofition on the Revelation*: an undertaking in which his rare talents in reafon and computation could however afford him no advantages; nor is he remembered by it. He died in 1622.

NEPER's *Rods*, or *Bones*, an inftrument invented by J. Neper, baron of Merchifton in Scotland, whereby the multiplication and divifion of large numbers is much facilitated.

As to the conftruction of NEPER's *Rod*: Suppofe the common table of multiplication to be made upon a plate of metal, ivory, or pafteboard, and then conceive the feveral columns (ftanding downwards from the digits on the head) to be cut afunder; and thefe are what we call *Neper's rods for multiplication*. But then there muft be a good number of each; for as many times as any figure is in the multiplicand, fo many rods of that fpecies (*i. e.* with that figure on the top of it) muft we have; though fix rods of each fpecies will be fufficient for any example in common affairs: there muft be alfo as many rods of o's.

But before we explain the way of ufing thefe rods, there is another thing to be known, *viz.* that the figures on every rod are written in an order different from that in the table. Thus the little fquare fpace or divifion in which the feveral products of every column are written, is divided into two parts by a line acrofs from the upper angle on the right to the lower on the left; and if the product is a digit, it is fet in the lower divifion; if it has two places, the firft is fet in the lower, and the fecond in the upper divifion; but the fpaces on the top are not divided: alfo there is a rod of digits, not divided, which is called the *index rod*, and of this we need but one fingle rod. See the figure of all the different rods, and the index, feparate from one another, in Plate CCI. fig. 1.

Multiplication by NEPER's *Rods*. Firft lay down the index-rod; then on the right of it fet a rod, whofe top is the figure in the higheft place of the multiplicand: next to this again, fet the rod, whofe top is the next figure of the multiplicand; and fo on in order, to the firft figure. Then is your multiplicand tabulated for all the nine digits; for in the fame line of fquares ftanding againft every figure of the index rod, you have the product of that figure; and therefore you have no more to do but to transfer the products and fum them. But in taking out thefe products from the rods, the order in which the figures ftand obliges you to a very eafy and fmall addition: thus, begin to take out the figure in the lower part, or unit's place, of the fquare of the firft rod on the right; add the figure in the upper part of this rod to that in the lower part of the next, and fo on; which may be done as faft as you can look on them. To make this practice as clear as poffible, take the following example.

Example: To multiply 4768 by 385. Having fet the rods together for the number 4768 (*ibid.* n° 2.) againft 5 in the index, I find this number, by adding

according to the rule, - -	23840
Againft 8, this number - -	38144
Againft 3, this number - -	14304
Total product - -	1835680

To make the ufe of the rods yet more regular and eafy, they are kept in a flat fquare box, whofe breadth is that of ten rods, and the length that of one rod, as thick as to hold fix (or as many as you pleafe) the capacity of the box being divided into ten cells, for the different fpecies of rods. When the rods are put up in the box (each fpecies in its own cell diftinguifhed by the firft figure of the rod fet before it on the face of the box near the top) as much of every rod ftands without the box as fhews the firft figure of that rod: alfo upon one of the flat fides without and near the edge, upon the left hand, the index rod is fixed; and along the foot there is a fmall ledge; fo that the rods when applied are laid upon this fide, and fupported by the ledge, which makes the practice very eafy; but in cafe the multiplicand fhould have more than nine places, that upper face of the box may be made broader. Some make the roads with four different faces, and figures on each for different purpofes.

Divifion by NEPER's *Rods*. Firft tabulate your divifor; then you have it multiplied by all the digits, out of which you may choofe fuch convenient divifors as will

will be next lefs to the figures in the dividend, and write the index anfwering in the quotient, and fo continually till the work is done. Thus 2179788, divided by 6123, gives in the quotient 356.

Having tabulated the divifor 6123, you fee that 6123 cannot be had in 2179; therefore take five places, and on the rods find a number that is equal or next lefs to 21797, which is 18369; that is, 3 times the divifor: wherefore fet 3 in the quotient, and fubftract 18369 from the figures above, and there will remain 3428; to which add 8, the next figure of the dividend, and feek again on the rods for it, or the next lefs, which you will find to be five times; therefore fet 5 in the quotient, and fubtract 30615 from 34288, and there will remain 3673; to which add 8, the laft figure in the dividend, and finding it to be juft 6 times the divifor, fet 6 in the quotient.

```
6123)2179788(356
     18369··
     -------
      34288
      30615
      -------
       36738
       36738
       -------
       00000
```

NEPETA, Catmint, or *Nep;* a genus of the gymnofpermia order, belonging to the didynamia clafs of plants. There are 14 fpecies; the moft remarkable is the cataria, common nep, or catmint. This is a native of many parts of Britain, growing about hedges and in wafte places. The ftalk is a yard high, and branched; the leaves are hoary; the flowers flefh-coloured, growing verticillate in fpikes at the tops of the branches: the middle fegment of the lower lip is fpotted with red. The plant has a bitter tafte, and ftrong fmell, not unlike pennyroyal. An infufion of this plant is reckoned a good cephalic and emmenagogue; being found very efficacious in chlorotic cafes. Two ounces of the expreffed juice may be given for a dofe. It is called *catmint*, becaufe cats are very fond of it, efpecially when it is withered; for then they will roll themfelves on it, and tear it to pieces, chewing it in their mouths with great pleafure. Mr Ray mentions his having tranfplanted fome of the plants of this fort from the fields into his garden, which were foon deftroyed by the cats; but the plants which came up from feeds in his garden efcaped: this verifies an old proverb, *viz.* "If you fet it, the cats will eat it; if you fow it, the cats will not know it." Mr Withering is of opinion, that where there is a quantity of plants growing together, the cats will not meddle with them; but Mr Millar affures us, that he has frequently tranfplanted one of thefe plants from another part of the garden, within two feet of which, fome came up from feeds; in which cafe the latter have remained unhurt, when the former have been torn to pieces and deftroyed: he acknowledges, however, that, where there is a large quantity of the herb growing together, they will not meddle with it. This plant is very hardy, and is eafily propagated by feeds. If fown upon a poor dry foil, the plants will not grow too rank, but will continue longer, and appear much handfomer, than in rich ground, where they grow too luxuriant, and have not fo ftrong a fcent.

NEPHEW, a term relative to uncle and aunt, fignifying a brother's or fifter's fon; who, according to the civil law, is in the third degree of confanguinity, but according to the canon in the fecond.

NEPHRITIC, fomething that relates to the kidneys. See Kidney.

Nephritic *Wood, (lignum nephriticum)*, a wood of a very denfe and compact texture, and of a fine grain, brought to us from New Spain in fmall blocks, in its natural ftate, and covered with its bark. It is to be chofen of a pale colour, found and firm, and fuch as has not loft its acrid tafte; but the fureft teft of it is the infufing it in water: for a piece of it infufed only half an hour in cold water, gives it a changeable colour, which is blue or yellow, as varioufly held to the light. If the vial it is in be held between the eye and the light, the tincture appears yellow; but if the eye be placed between the light and the vial, it appears blue. We often meet with this wood adulterated with others of the fame pale colour; but the dufkifh black hue of the bark is a ftriking character of this.

The tree is the *coatli* of Hernandez. It grows to the height of our pear-tree, and its wood while frefh is much of the fame texture and colour; the leaves are fmall and oblong, not exceeding half an inch in length, or a third of an inch in breadth; the flowers are fmall, of a pale-yellow colour, and oblong fhape, ftanding in fpikes: the cups they ftand in are divided into five fegments at the edge, and are covered with a reddifh down. This is the beft defcription of the tree that can be collected from what has been hitherto written of it; nobody having yet had an opportunity of taking its true characters.

This wood is a very good diuretic, and is faid to be of great ufe with the Indians in all difeafes of the kidneys and bladder, and in fuppreffion of urine, from whatever caufe. It is alfo recommended in fevers, and in obftructions of the vifcera. The way of taking it among the Indians is only an infufion in cold water.

Nephritic *Stone*, a foft, brittle, opaque ftone, not fufceptible of a good polifh; fmooth, and, as it were, unctuous to the touch; variegated with feveral colours, of which green is the principal. It is found in Saxony, Bohemia, Switzerland, Spain, and Mexico; and from the imaginary virtues afcribed to it in nephritic diforders, has been ranked among the precious ftones, but differs exceedingly from them in all its fenfible qualities. Neumann finds fault with fome authors for referring this ftone to the jafpers, agates, or marbles; from all of which, he fays, it widely differs: it wants the red fpecks of the jafpers, the hardnefs and compactnefs of the others, and all of them want its unctuofity or foapinefs. Out of 60 grains of nephritic ftone, vinegar diffolved three; oil of vitriol feven; fpirit of vitriol 14; fpirit of nitre 16; aqua regia 18; and fpirit of falt 20. The fpirit of falt acquired a greenifh-yellow tincture; aqua regia a gold yellow; oil of vitriol a dark-brownifh; the other acids remained colourlefs. Both the marine acid and aqua regia left the undiffolved earth whitifh; the nitrous acid greyifh; the diluted vitriolic acid brownifh-yellow; the concentrated light reddifh-brown; the acetous,

tous, unchanged. An ounce of this fubftance powdered, and diftilled in a retort in an open fire, yielded about a drachm and an half of phlegm, which had a penetrating empyreumatic fmell, but made no change in the colour of the fyrup of violets. On diftilling four ounces together, there was an appearance of an actual empyreumatic oil, with a faline matter, which was found to be fal ammoniac. The matter remaining in the retort was of a reddifh-brown colour. An ounce of the powdered ftone, mixed with an equal quantity of fixed alkaline falt, and urged with a ftrong fire, did not melt, but formed a quite porous mafs, in colour inclining to reddifh-grey, and weighing two drachms lefs than the mixture did at firft. Dr Lewis tells us, that the nephritic ftone is a fpecies of the indurated clays, called, from their unctuofity, *fteatitæ*. With thefe it agrees, not only in its obvious properties, but likewife in its burning hard, the peculiar characteriftic of argillaceous earths. Its green colour feems to proceed from copper. Pott relates, that on fufion with an equal quantity of borax, it yielded a beautiful red mafs refembling an agate, with a grain of copper at the bottom. The nephritic ftone is confiderably the hardeft of all the fubftances of this clafs.

NEPHRITICS, in pharmacy, medicines proper for difeafes of the kidneys, efpecially the ftone.—Such particularly are the roots of althæa, dog's-grafs, afparagus, fago, pellitory of the wall, mallows, pimpinella, red chick-peafe, peach-kernels, turpentine, &c.

NEPHRITIS, or inflammation of the kidneys. See MEDICINE, n° 304.

NEPOS (Cornelius), a celebrated Latin hiftorian, born at Hoftilia near Verona, flourifhed in the time of the emperor Auguftus. He was the friend of Cicero and Atticus; and compofed feveral excellent works, of which there are only extant the lives of the moft illuftrious Greek and Roman captains.

NEPTUNE, in Pagan worfhip, the god of the fea, was the fon of Saturn and Vefta, or Ops, and the brother of Jupiter and Pluto. He affifted Jupiter in his expeditions; on which that god, when he arrived at the fupreme power, affigned him the fea and the iflands for his empire. He was, however, expelled from heaven with Apollo, for confpiring againft Jupiter, when they were both employed by Laomedon king of Phrygia in building the walls of Troy; but that prince difmiffing Neptune without a reward, he fent a fea-monfter to lay wafte the country, on which he was obliged to expofe his daughter Hefione. He is faid to have been the firft inventor of horfemanfhip and chariot-racing; on which account Mithridates king of Pontus threw chariots drawn by four horfes into the fea in honour of this god; and the Romans inftituted horfe-races in the circus at his feftival, during which all other horfes left working, and the mules were adorned with wreaths of flowers.

In a conteft with Minerva he produced a horfe by ftriking the earth with his trident; and on another occafion, in a trial of fkill with Minerva and Vulcan, produced a bull, whence that animal was facrificed to him. His favourite wife was Amphytrite, whom he long courted in vain, till fending the dolphin to intercede for him, he met with fuccefs; on which he rewarded the dolphin by placing him among the ftars. He had alfo two other wives, one of whom was called *Salafia*, from the falt water; the other *Venilia*, from the ebbing and flowing of the tides. He had likewife many concubines, by whom he had a great number of children. He is reprefented with black hair, with a garment of an azure or fea-green, holding his trident in his hand, and feated in a large fhell drawn by fea-horfes, attended by the fea-gods Palemon, Glaucus, and Phorcys, and the fea goddeffes Thetis, Melita, and Panopæa, and a long train of tritons and fea-nymphs.

NEREIDS, in the Pagan theology, fea-nymphs, daughters of Nereus and Doris.—The Nereids were efteemed very handfome; infomuch that Caffiope, the wife of Cepheus king of Ethiopia, having triumphed over all the beauties of the age, and daring to vie with the Nereids, they were fo enraged that they fent a prodigious fea-monfter into the country; and, to appeafe them, fhe was commanded by the oracle to expofe her daughter Andromeda, bound to a rock, to be devoured by the monfter. In ancient monuments, the Nereids are reprefented riding upon fea-horfes; fometimes with an entire human form, and at other times with the tail of a fifh.

NEREIS, in zoology, a genus of animals belonging to the order of vermes mollufca. The body is oblong, linear, and fitted for creeping; it is furnifhed with lateral pencilled tentacula. There are 11 fpecies; of which the moft remarkable is the noctiluca, being one of the caufes of the luminoufnefs of the fea. They are inhabitants of almoft every fea; and illuminate the water like glow-worms, but with a brighter fplendour, fo as at night to make the element appear as if on fire all around. Their bodies are fo minute as to elude examination by the naked eye.

NEREUS, in fabulous hiftory, a marine deity, was the fon of Oceanus and Thetis. He fettled in the Ægean Sea, was confidered as a prophet, and had the power of affuming what form he pleafed. He married his fifter Doris, by whom he had 50 daughters called the *Nereids*, who conftantly attended on Neptune, and when he went abroad furrounded his chariot.

NERO (Domitius) emperor, fon of Caius Domitius Ænobarbus, and of Agrippina, who married Claudius, whom Nero fucceeded, A. D. 54, aged 18. He protefted he would follow the example of Auguftus, and at firft he did; and as they once prefented him the fentence of a perfon condemned to death, "I wifh," faid he, "that I could not write." But after five years reign he fell into the moft extravagant crimes that ever entered the imagination of man. He would appear upon the ftage in wonan's drefs. He commited fodomy with the greateft debauchees, and particularly Sporus, whom he kept in quality of his wife, and caufed to be dreffed like a woman; which gave occafion to that pleafant faying, "That the world had been happy if his father Domitius had had fuch a wife." He caufed his mother to be murdered, his wife to be put to death, and his mafter Seneca to lofe his life, &c. and wifhed that mankind had but one head, that he might have the pleafure of cutting it off. To have the glory of rebuilding Rome, he fet it on fire, laid the blame upon the Chriftians, and began the firft perfecution againft them.

them. Being exhausted by his immense profusion, and become the common detestation of mankind, his armies in Gaul declared against him, and Galba revolted in Spain. This cast him into despair, and in a rage he cried out, "Have I neither friend nor enemy?" So he was forced to turn his own executioner, A. D. 68, in the 32d year of his age and 14th of his reign.

NERVA (Cocceius), emperor after Domitian. He recalled those who had been banished for their religion, and forgot nothing that might contribute to the restoring of the empire to its former lustre; but finding his age would not suffer him to finish it, he adopted Trajan, and died A. C. 98.

NERVES, in anatomy; certain white glistening cords, proceeding from the brain and spinal marrow, and dividing into very small branches, which are sent off throughout all parts of the body; and which are found to be the organs of sensation and motion. See ANATOMY, n° 400.

NERVOUS FLUID. See ANATOMY, n° 400, l.

NEST. See NIDUS.

Eatable Birds-NESTS. See BIRDS-*Nests*.

NESTOR, in fabulous history, king of Pylos, and the son of Neleus and Chloris. He subdued the Eleans, and conquered the Centaurs, who would have carried off Hippodamia. He afterwards went to the siege of Troy with Agamemnon, who had a particular esteem for him on account of his wisdom and eloquence. He was then, according to Homer, so old, that he had seen three generations of men.

NESTORIANS, a Christian sect, the followers of Nestorius bishop and patriarch of Constantinople; who, about the year 520, taught that there were two persons in Jesus Christ, the divine and the human, which are united not hypostatically or substantially, but in a mystical manner; whence he concluded, that Mary was the mother of Christ, and not the mother of God. For this opinion Nestorius was condemned and deposed by the council of Ephesus; and the decree of this council was confirmed by the emperor Theodosius, who banished the bishop to a monastery.

NET, a device for catching fish and fowl. See the article FISHERY.

The taking fowls by nets is the readiest and most advantageous of all others, where numbers are to be taken. The making the nets is very easy, and what every true sportsman ought to be able to do for himself. All the necessary tools are wooden needles, of which there should be several of different sizes, some round and others flat; a pair of round-pointed and flat scissars; and a wheel to wind off the thread. The packthread is to be of different strength and thickness, according to the sort of birds to be taken; and the general size of the meshes, if not for very small birds, is two inches from point to point. The nets should neither be made too deep nor too long, for they are then difficult to manage; and they must be verged on each side with twisted thread. The natural colour of the thread is too bright and pale, and is therefore in many cases to be altered. The most usual colour is the russet; which is to be obtained by plunging the net, after it is made, into a tanner's pit, and letting it lie there till it be sufficiently tinged: this is of a double service to the net, since it preserves the thread as well as alters the colour. The green colour is given by chopping some green wheat and boiling it in water, and then soaking the net in this green tincture. The yellow colour is given in the same manner with the decoction of celandine; which gives a pale straw-colour, which is the colour of stubble in the harvest-time. The brown nets are to be used on ploughed lands, the green on grass-grounds, and the yellow on stubble-lands.

NET, *Neat*, in commerce, something pure, and unadulterated with any foreign mixture.

Thus, wine is said to be *net* when not falsified or balderdashed; and coffee, rice, pepper, &c. are *net* when the filth and ordures are separated from them. See NEAT.

A diamond is said to be *net* when it has no stains or flaws; a crystal, when transparent throughout.

NET is also used for what remains after the tare has been taken out of the weight of any merchandise; *i. e.* when it is weighed clear of all package. See TARE.

Thus we say, a barrel of cochineal weighs 450 pounds; the tare is 50 pounds, and there remains *net* 400 pounds.

NET *Produce*, a term used to express what any commodity has yielded, all tare and charges deducted.

The merchants sometimes use the Italian words *netto proceduto*, for net produce.

NETHERLANDS, anciently called *Belgia*, but since denominated *Low Countries* or *Netherlands*, from their low situation, are situated between 2° and 7° of east longitude, and between 50° and 53° 30′ of north latitude: and are bounded by the German sea on the north, Germany on the east, by Lorrain and France on the south, and by another part of France and the British seas on the west; extending near 300 miles in length from north to south, and 200 miles in breadth from east to west. They consist of 17 provinces; 10 of which are called the *Austrian and French Netherlands*, and the other seven the *United Provinces*.

The *Austrian Netherlands* consist of the greatest part of the duchies of Brabant, Limburg, and Luxemburg, with a part of that of Gueldres; and of the counties of Flanders, Hennegau, and Namur. The Netherlands formerly made a part of the circle of Burgundy, the whole of which once belonged to the house of Austria, and on the death of Charles V. devolved to the Burgundian Spanish line of that house; but was all afterwards lost, except the abovementioned countries, which, on the death of Charles II. king of Spain, fell to the German line of the Austrian family. These Austrian Netherlands are still considered as a circle of the empire, of which the archducal house, as being sovereign of the whole, is the sole director and summoning prince. This circle contributes its share to the imposts of the empire, and sends an envoy to the diet; but is not subject to the judicatories of the empire. It is wholly Catholic, and under a governor-general appointed by the court of Vienna.

The *French Netherlands* consist of a part of the duchy of Luxemburg, of the province of Hainault, of the earldom of Flanders, the bishopric of Liege, the Cambresis, and the county of Namur; and this government, the greatest part of which belongs to the parliament of Douay, comprehends French Flanders,

the

the Cambrefis, French Hainault, and the French part of the earldom of Namur.—French Flanders abounds in grain, vegetables, flax, and cattle, but is in want of wood.

For the *Dutch Netherlands*, fee UNITED *Provinces*.

NETSCHER (Gafpard), an eminent painter, born at Prague in Bohemia in 1639. His father dying while he was an engineer in the Polifh fervice, his mother was obliged, on account of her religion, fuddenly to leave Prague with her three fons. When fhe had proceeded three leagues, fhe ftopped at a caftle; which being foon after befieged, two of her fons were ftarved to death; but fhe herfelf found means to efcape out of the fortrefs by night, and to fave her only remaining child. Carrying him in her arms, fhe reached Arnheim in Guelderland, where fhe found means to fupport herfelf, and breed up her fon. At length a doctor of phyfic took young Netfcher into his patronage, with the view of giving him an education proper for a phyfician: but Netfcher's genius leading him to painting, he could not forbear fcrawling out defigns upon the paper on which he wrote his themes; and it being found impoffible to conquer his fondnefs for drawing, he was fent to a glazier, who was the only perfon in the town that underftood drawing. Netfcher foon finding himfelf above receiving any farther affiftance from his mafter, was fent to Deventer, to a painter named *Terburg*, who was an able artift and burgomafter of the town; and having acquired under him a great command of his pencil, went to Holland, where he worked a long time for the dealers in pictures, who paid him very little for his pieces, which they fold at a high price. Difgufted at this ungenerous treatment, he refolved to go to Rome, and for that purpofe embarked on board a veffel bound for Bourdeaux. But his marrying in that city prevented his travelling into Italy: and therefore, returning into Holland, he fettled at the Hague; where obferving that portait-painting was the moft profitable, he applied himfelf folely to it, and acquired fuch reputation, that there is not a confiderable family in Holland that has not fome of his portraits; and befides, the greateft part of the foreign minifters could not think of quitting Holland without carrying with them one of Netfcher's portraits, whence they are to be feen all over Europe. He died at the Hague, in 1684; leaving two fons, Theodore and Conftantine Netfcher, both of them good portrait-painters.

NETTINGS, in a fhip, a fort of grates made of fmall ropes feized together with rope-yarn or twine, and fixed on the quarters and in the tops; they are fometimes ftretched upon the ledges from the wafte-trees to the roof-trees, from the top of the forecaftle to the poop, and fometimes are laid in the wafte of a fhip to ferve inftead of gratings.

NETTLE, in botany. See URTICA.

Sea-NETTLE. See MEDUSA, and ANIMAL-*Flower*.

NETTLE-*Tree*. See CELTIS.

NETTUNO, a handfome town of Italy, in the Campagnia of Rome. It is but thinly peopled, though feated in a fertile foil. The inhabitants are almoft all hunters. E. Long. 12. 57. N. Lat. 41. 30.

NEWBURG, the name of feveral towns of Germany, two of which are the chief towns of duchies of the fame name; one in Bavaria, and the other in the Palatinate.

NEVERS, a confiderable town of France, and capital of Nivernois, in Orleanois, with the title of a duchy, an ancient caftle, and a bifhop's fee. It is built in the form of an amphitheatre, and contains feveral fine buildings. It is feated on the river Loir, over which there is an handfome bridge, and at the end of it a fine large caufeway reaching to the town. E. Long. 3. 14. N. Lat. 46. 59.

NEUFCHATTEAU, a town of France, in Lorrain, and capital of the chatellenie of Chatenoi. It is an handfome, populous, trading town; having an abbey of the nuns of St Clair, a commandery of Malta, and feveral convents of monks and nuns. It is feated in a bottom, in a foil fertile in corn, wine, and all the neceffaries of life, on the river Mouzon. E. Long. 5. 45. N. Lat. 48. 20.

NEUFCHATTEL, a fovereign county of Swifferland, bounded on the weft by the Franche Comte, on the north by the bifhopric of Bafle, and on the eaft and fouth by the cantons of Berne and Friburg; it is about 40 miles in length, and 20 in breadth. It had its own counts for a long time; the laft of whom dying in 1694 without iffue, it came to Mary of Orleans, duchefs of Nemours, his only fifter, who died without iffue in 1703: there were then 13 competitors; but, at an affembly of the ftates in 1707, they unanimoufly chofe the king of Pruffia for their fovereign, who has placed a governor therein. It is well peopled; and contains three cities, one town, 90 villages, and about 300 houfes difperfed in the mountains. The inhabitants are all Proteftants, except two Roman Catholic villages; and in 1529 they entered into a ftrict alliance with the cantons of Berne, Friburg, Soleure, and Lucern. The air is healthy and temperate, but the foil not every where equally fertile; however, there are large vineyards, which produce white and red wine, which laft is excellent. The paftures on the mountains feed a great number of all forts of cattle; and there are plenty of deer in the forefts; befides large trouts, and other good fifh, in the lakes and rivers. The people are ingenious, polite, active, induftrious, and laborious.

NEUFCHATTEL, an handfome town of Swifferland, capital of a county of the fame name. There are feveral ancient ruins near it, which fhew its former extent; and there are two large churches, befides a caftle where the governor refides. It is feated on a lake of the fame name, 17 miles in length and five in breadth, and the fide of the harbour is the ufual walk of the inhabitants. It has a grand and little council: the firft is compofed of 40 perfons, with two mafters of the keys; the little council confifts of 24 members, comprehending the mayor, who is prefident. Thefe two councils affemble regularly every month. The ecclefiaftics likewife affemble every month, to confult on affairs belonging to the church, and to fill up the places of minifters that die. They choofe a dean every year, who is prefident of the general affemblies, which are called *claffes*; and fometimes he is confirmed in this dignity. E. Long. 7. 10. N. Lat. 47. 5.

NEVIS, one of the Caribbee iflands, lying about feven leagues north of Montferrat, and feparated from St Chriftopher's by a narrow channel. It makes a beautiful appearance from the fea, being a large conical

cal mountain covered with fine trees, of an eafy afcent on every fide, and entirely cultivated. The circumference is about 21 miles, with a confiderable tract of level ground all around. The climate in the lower part is reckoned to be warmer than Barbadoes, but it is more temperate towards the fummit. The foil is very fine in the lower part, but grows coarfer as we afcend. The productions are nearly the fame with thofe of St Chriftopher. There are three pretty good roads or bays, with fmall towns in their vicinity; Charles-town, Moreton-Bay, and Newcaftle. This pleafant ifland was fettled under the aufpices of Sir Thomas Warner from St Chriftopher's. His fucceffor, governor Lake, was confidered as the Solon of this little country, in which he difpofed of every thing with fuch prudence, wifdom, and juftice, as procured him an high reputation with the French as well as Englifh. In the Dutch war they met with fome difturbance from the French; but by being covered by an Englifh fquadron, the enemy were obliged to defift from their intended invafion, after a fmart engagement in fight of the ifland. Sir William Stapleton fometimes refided here, and Sir Nathaniel Johnfon conftantly, at which time the inhabitants of Nevis were computed at 30,000. In the war immediately after the revolution, they exerted themfelves gallantly, and had two regiments of 300 men each. In that of queen Anne they behaved equally well, tho' they were lefs fortunate; for the French landing with a fuperior force, and having inveigled moft of their flaves, they were forced to capitulate. About 4000 of thefe flaves the French carried away and fold to the Spaniards, to work in their mines. The parliament, after making due inquiry into the loffes they had fuftained, voted them about a third part of the fum in which they had fuffered. Thefe loffes by war, an epidemic difeafe, and repeated hurricanes, exceedingly diminifhed the number of the people. They are now thought not to exceed 2000 or 3000 whites, and 6000 blacks. There is here a lieutenant-governor, with a council, and an affembly, which is compofed of three members from each of the five parifhes into which the ifland is divided. The commodities are cotton and fugar; and about 20 fail of fhips are annually employed in this trade.

NEURITICS, in pharmacy, medicines good in diforders of the nerves.

NEUROGRAPHY, fignifies a defcription of the nerves. See ANATOMY, n° 400.

NEUROPTERA. See ZOOLOGY.

NEUTER, a perfon indifferent, who has efpoufed neither party, and is neither friend nor foe.

A judge ought to be neuter in the caufes he judges; in queftions, where reafon appears neuter, a man fhould ever incline to the fide of the unhappy.

NEUTER, in grammar, denotes a fort of gender of nouns, which are neither mafculine nor feminine. See GENDER.

The Latins have three kinds of genders, mafculine, feminine, and neuter. In Englifh, and other modern tongues, there is no fuch thing as neuter nouns. See NOUN.

Verbs NEUTER, by fome grammarians called *intranfitive verbs*, are thofe which govern nothing, and that are neither active nor pofitive. See VERB.

When the action expreffed by the verb has no object to fall upon, but the verb alone fupplies the whole idea of the action; the verb is faid to be *neuter*: as, I fleep, thou yawneft, he fneezes, we walk, ye run, they ftand ftill.

Some divide verbs neuter into, 1. Such as do not fignify any action, but a quality; as *albet*, "it is white;" or a fituation, as *fedet*, "he fits:" or have fome relation to place; as *adeft*, "he is prefent;" or to fome other ftate or attribute, as *regnat*, "he rules," &c. And, 2. Thofe that do fignify actions, though thofe fuch as do not pafs into any fubject different from the actor; as to dine, to fup, to play, &c.

But this latter kind fometimes ceafe to be *neuter*, and commence active; efpecially in Greek and Latin, when a fubject is given them: as, *vivere vitam*, *ambulare viam*, *pugnare pugnam*. Thus the old French poets fay, *Soupirer fon tourment*; the Englifh, to *figh his woes*, &c.

But this is obferved only to obtain where fomething particular is to be expreffed, not contained, in the verb: as, *vivere vitam beatam*, to live a happy life; *pugnare bonam pugnam*, to fight a good fight, &c.

According to the abbot de Dangeau, *verbs neuter* may be divided into *active* and *paffive*; the firft, thofe that form their tenfes in Englifh, by the auxiliary verb *to have*; in French, by *avoir*. The fecond, thofe that form them in Englifh with the verb *to be*; in French *etre*.—Thus, to fleep, to yawn, *dormir* and *eternuer*, are *neuters active*.—To come, and to arrive, are *neuters paffive*.

NEUTRAL *Salts*, among chemifts, thofe compounded of an acid with any other fubftance capable of uniting with it and deftroying its acidity. Thofe in which the acid is faturated with an earth or a metal are called *imperfect*, but thofe in which a pure alkali is employed are called *perfect*, neutrals.

NEUTRALITY, the ftate of a perfon or thing that is neuter, or that takes part with neither fide.

NEWCASTLE, the capital of the county of Northumberland in England, a large, populous, and flourifhing town, fituated on the north bank of the river Tyne, about 300 miles to the northward of London. It is connected, by means of a bridge with the fuburbs of Gatefhead, which, being on the fouthern fide of the river, is part of the bifhopric of Durham. Near the fpot where the town now ftands, there was of old a fort called *Moncafter*; and Robert, fon of William the Conqueror, having built another to overawe the Scots, beftowed upon it the name of *Newcaftle*, in contradiftinction to the old fortrefs. Divers monafteries and hofpitals being raifed around it, the place, in a little time, fwelled into a town; and the walls of it were begun in the reign of Edward I. by a rich burgher, who had been taken by the Scots, and paid a large ranfom for his liberty. It is at prefent furrounded by a ftrong wall, in which there are feven gates and as many turrets, with fome cafemates faid to be bomb-proof. It was created a borough by king Richard II. who granted permiffion to carry a fword before the mayor; and king Henry VI. erected it into a town and county incorporate, independent of Northumberland. The magiftracy confifts of a mayor, 19 aldermen, a fheriff, a recorder, a town-clerk, a clerk of the chambers, two coroners, eight chamberlains, a fword-bearer, with a

cap of maintenance, a water-bailiff with a great mace, and feven ferjeants at mace. Newcaftle has been expofed to frequent incurfions and fieges of the Scots, before the union of the two crowns; and in the great rebellion, the army of that kingdom, under the command of Leflie, took it by ftorm: but it has long ago retrieved all its loffes, and become the great emporium of the north of England for coal and other merchandize. The town is built upon the declivity of a hill, which renders the ftreets fteep and incommodious. The houfes are crowded together fo as to exhibit but a difagreeable appearance: yet one or two of the ftreets are large, fpacious, and well paved. The town is overlooked by the old ruinous caftle: the exchange and cuftom-houfe are magnificent buildings, but too clofe to the river; along the bank of which there is a fine key or wharf faced with freeftone, to which fhips of ordinary burden can carry their broadfides to be loaded or unloaded. But the coal-fhips are loaded at or near Shields, feven miles farther down the river; their lading being conveyed thither in lighters, which they call *keels*. The number of the keelmen who work in thefe lighters, exceed 6000, who live in a fuburb called *Sandgate*. They have, by a contribution among themfelves, built a noble hofpital for fuch of their poor brethren as are difabled by accident, or fuperannuated and paft labour. The principal church of Newcaftle, called *St Nicholas*, is a ftately old fabric, built by David king of Scotland, with a fine fteeple of rare architecture: here are, befides, fix churches or chapels. We may number among the public edifices, an elegant manfion-houfe for the mayor; a noble hall for the furgeons, with a mufeum; a ftately infirmary on the model of that at Edinburgh; a library belonging to the corporation; a large prifon called *Newgate;* feveral meeting-houfes, and charity-fchools well endowed. The number of inhabitants amounts to above 40,000; and many of them are wealthy, and live with fplendour. They are generally bold, rough, and induftrious; enriching themfelves with the coal-trade, and other branches of commerce and manufacture, fuch as fhip-building, glafs-making, falt-works, and hard-ware or wrought iron. The place is particularly famous for grind-ftones, which are exported to all the countries in Europe. The fafhionable people live in the upper part of the town, at a diftance from the river, where they poffefs elegant houfes and gardens, and enjoy themfelves at comedies, affemblies, and other polite diverfions. The houfes are chiefly built of ftone, fome are of brick, and a very few of timber. The revenue of the town, amounting to 8000 l. a-year, is confiderably larger than that of any other corporation-borough in England: and from this the mayor is indulged with an annual allowance of 600 l. befides the maintenance of a coach, barge, and manfion-houfe.

NEWCASTLE (Duke of). See CAVENDISH.

NEWEL, in architecture, is the upright poft which a pair of winding ftairs turn about; this is properly a cylinder of ftone, which bears on the ground, and is formed by the end of the fteps of the winding ftairs.

NEWFIDLER-SEA, a lake in Hungary, 17 miles in length, and 6 in breadth.

NEWFOREST, a part of Hampfhire, lying on the Englifh channel, oppofite to the Ifle of Wight. It was made by William the Conqueror, who caufed 36 churches, and all the houfes belonging thereto, to be pulled down, that there might be no obftruction in hunting the game. It is now appropriated by act of parliament for the production of oaks, to be employed in building the royal navy.

NEWFOUNDLAND, a large ifland of North America, belonging to Great Britain, lying between 46. 50. and 51. 30. N. Lat. and between 53. 30. and 58. 20. W. Long. from London. The form is that of an irregular triangle, the bafe or fouth fide being 80 leagues in extent; the eaft fide is the longeft; and the whole circumference about 150 leagues. It is bounded on the north by the Straits of Belleifle, which feparate it from Labrador; on the eaft and fouth it hath the Atlantic Ocean, and on the weft the Gulph of St Laurence. The climate is rather fevere; and the foil, at leaft on the fea-coaft, which is all that we know of it, is poor and barren. A few kitchen vegetables with ftrawberries and rafberries are all its produce. The country within land is mountainous, and abounds with timber; there are feveral rivers which are plentifully ftored with various forts of fifh, abundance of deep bays, and many good ports. St John's and Placentia are the two principal fettlements, and at each of thefe there is a fort; the number of people who remain here in the winter hath been computed at 4000. The French, by the treaty of Utrecht, were permitted to fifh from Cape Bonavifta on the eaft fide round the north of the ifland to Point Rich on the weft; and by the treaty of Paris, they are allowed the ifles of St Pierre and Miquelon, upon which they are to dry their fifh, but not to erect fortifications of any kind.

The great importance of this place arifes from its fifhery, which is in part carried on by the inhabitants at the feveral harbours, which are about 20 in number, who take vaft quantities of cod near the coaft, which they bring in and cure at their leifure, in order to have it ready for the fhips when they arrive. But the great and extenfive fifhery is on the banks at fome diftance from the ifland. The great bank lies 20 leagues from the neareft point of land from the latitude of 41 to 49, ftretching 300 miles in length and 75 in breadth. To the eaft of this lies the Falfe Bank; the next is ftyled *Vert* or *the Green Bank*, about 240 miles long, and 120 over; then Banquero, about the fame fize; the fhoals of Sand Ifland, Whale Bank, and the Bank of St Peter's, with feveral others of lefs note, all abounding with fifh.

The cod are caught only by a hook, and an expert fifher will take from 150 to 300 and upwards in a day; for the fifh never bite in the night, and the labour is very great. The feafon is from May to October, in the height of which there are from 500 to 700 fail upon the banks at a time. The fifh caught in the fpring-months are beft; they are cured in very different ways. Some are ftyled *white fifh*, others *mud fifh*, which are ftowed and falted in the hold, and will not keep long; but the beft and moft valuable are the dried cod. The quantity taken is prodigious; yet in fome feafons and in different places varies confiderably, as the fifh frequently change their ftations. The *fifhing-fhips*, as they are called, lie upon the banks, with the help of their

Newfoundland ‖ Newton.

their boats take and cure their own fiſh, and as ſoon as they are full ſail for a market. The ſack-ſhips proceed directly to the iſland, where they purchaſe fiſh from the inhabitants either by barter or bills of exchange. The principal markets for cod are Spain, Portugal, Italy, and the Weſt Indies. The value of this fiſhery is computed at ſome hundred thouſand pounds anually; employing, beſides ſeveral hundred ſhips, ſome thouſands of ſeamen, and affording a maintenance to a number of tradeſmen of different occupations, by which many large towns on the weſt ſide of England accumulate much wealth, and at the ſame time contribute in many reſpects to the benefit of the public.

The great utility of this fiſhery was very early ſeen, and very vigorouſly purſued; for in the beginning of the reign of king James I. we had two hundred and fifty ſail employed therein. It is computed, that three quintals of wet fiſh make one quintal of dried cod. Beſides, the livers of every hundred quintals make a hogſhead of oil; and excluſive of theſe, there are many leſſer advantages that go in diminution of the expence. The fiſhery, as we have ſaid above, produces differently in different ſeaſons; but it is judged to be a very good one when it produces 300,000 quintals of fiſh, and 3000 barrels of oil, both equally saleable and valuable commodities. As every ſhip carries 12, and each of their boats eight men, and as theſe return home in ſix months, there cannot be a more noble nurſery for ſeamen. The artificers and traders employed in building, victualling, and repairing theſe veſſels, are very numerous in the reſpective ports from which they ſail. Theſe circumſtances juſtify the particular attention paid by government to this branch of the public ſervice; in reſpect to which, that they may be well informed, an annual and very diſtinct account, by which the whole is ſeen at one view, is delivered by the proper officer to the governor of Newfoundland, that is, to the commodore of his majeſty's ſquadron.

NEWMARKET, a town of England, partly in Cambridgeſhire, and partly in Suffolk. It conſiſts of one well-built ſtreet, ſeated on the great road, and full of inns. It is chiefly noted for its horſe-races. E. Long. 0. 25. N. Lat. 52. 16.

NEWT, or Eft, in zoology, the common lizard. See Lacerta.

NEWTON (Sir Iſaac), one of the greateſt philoſophers and mathematicians the world has produced, was the only child of Mr John Newton of Coleſworth, not far from Grantham in Lincolnſhire, who had an eſtate of about 120*l. per annum*, which he kept in his own hands. He was born at that place on Chriſtmas-day 1642. His father dying when he was young, his mother's brother, a clergyman of the name of *Ayſcough*, or *Aſkew*, who lived near her, and directed all her affairs after the death of Mr Newton, put her ſon to ſchool at Grantham. When he had finiſhed his ſchool-learning, his mother took him home; intending, as ſhe had no other child, to have the pleaſure of his company; and that he, as his father had done, ſhould occupy his own eſtate. But his uncle happening to find him in a hay-loft at Grantham, working a mathematical problem, and having otherwiſe obſerved the boy's mind to be uncommonly bent upon learning, he prevailed upon her to part with him; and ſhe ſent him

Newton.

to Trinity College in Cambridge, where her brother, having himſelf been a member of it, had ſtill many friends. Iſaac was ſoon taken notice of by Dr Iſaac Barrow; who, obſerving his bright genius, contracted a great friendſhip for him. M. De Fontenelle tells us, "That in learning mathematics he did not ſtudy Euclid, who ſeemed to him too plain and ſimple, and unworthy of taking up his time. He underſtood him almoſt before he read him, and a caſt of his eye upon the contents of his theorems was ſufficient to make him maſter of them. He advanced at once to the geometry of Des Cartes, Kepler's optics, &c. It is certain, that he had made his great diſcoveries in geometry, and laid the foundation of his two famous works the *Principia* and the *Optics*, by the time he was 24 years of age."

In 1664, he took the degree of bachelor of arts; and in 1668 that of maſter, being elected the year before fellow of his college. He had before this time diſcovered the method of fluxions; and in 1669, he was choſen profeſſor of mathematics in the univerſity of Cambridge, upon the reſignation of Dr Barrow. The ſame year, and the two following, he read a courſe of optical lectures in Latin, in the public ſchools of the univerſity; an Engliſh tranſlation of which was printed at London in 1728 in 8vo, as was the Latin original the next year in 4to. From the year 1671 to 1679, he held a correſpondence, by letters, with Mr Henry Oldenburg, ſecretary of the royal ſociety, and Mr John Collins, fellow of that ſociety; which letters contain a variety of curious obſervations.

Concerning the origin of his diſcoveries, we are told that as he ſat alone in a garden, the falling of ſome apples from a tree led him into a ſpeculation on the power of gravity; that as this power is not diminiſhed at the remoteſt diſtance from the centre of the earth to which we can riſe, it appeared to him reaſonable to conclude, that it muſt extend much farther than was uſually thought; and purſuing this ſpeculation by comparing the periods of the ſeveral planets with their diſtances from the ſun, he found, that if any power like gravity held them in their courſes, its ſtrength muſt decreaſe in the duplicate proportion of the increaſe of diſtance. This inquiry was dropped; but reſumed again, and gave riſe to his writing the treatiſe which he publiſhed in 1687 under the name of *Mathematical Principles of Natural Philoſophy*; a work looked upon as the production of a celeſtial intelligence rather than of a man. The very ſame year in which this great work was publiſhed, the univerſity of Cambridge was attacked by king James II. when he was one of its moſt zealous defenders, and was accordingly nominated one of the delegates of that univerſity to the high-commiſſion court; and the next year he was choſen one of their members for the convention-parliament, in which he ſat till it was diſſolved. In 1696, Mr Montague, then chancellor of the exchequer, and afterwards earl of Halifax, obtained for him of the king, the office of warden of the mint; in which employment he was of ſignal ſervice, when the money was called in to be recoined. Three years after, he was appointed maſter of the mint; a place of very conſiderable profit, which he held till his death. In 1699, he was elected one of the members of the royal aca-

Newton. demy of ſciences at Paris. In 1701, he was a ſecond time choſen member of parliament for the univerſity of Cambridge. In 1704, he publiſhed his *Optics;* which is a piece of philoſophy ſo new, that the ſcience may be conſidered as entirely owing to our author. In 1705, he was knighted by queen Anne. In 1707, he publiſhed his *Arithmetica Univerſalis*. In 1711, his *Analyſis per Quantitatum Series, Fluxiones et Differentias,* &c. was publiſhed by William Jones Eſq. In 1712, ſeveral letters of his were publiſhed in the *Commercium Epiſtolicum*. In the reign of George I. he was better known at court than before. The princeſs of Wales, afterwards qneen-conſort of England, uſed freqnently to propoſe queſtions to him, and to declare that ſhe thought herſelf happy to live at the ſame time with him, and have the pleaſure and advantage of his converſation. He had written a treatiſe of ancient chronology, which he did not think of publiſhing; but the princeſs deſired an abſtract, which ſhe would never part with. However, a copy of it ſtole abroad, and was carried into France; where it was tranſlated and printed, with ſome obſervations, which were afterwards anſwered by Sir Iſaac. But, in 1728, the Chronology itſelf was publiſhed at London in quarto; and was attacked by ſeveral perſons, and as zealouſly defended by Sir Iſaac's friends. The main deſign of it was to find out, from ſome tracts of the moſt ancient Greek aſtronomy, what was the poſition of the colures with reſpect to the fixed ſtars, in the time of Chiron the centaur. As it is now known that theſe ſtars have a motion in longitude of one degree in 72 years, if it is once known thro' what fixed ſtars the colure paſſed in Chiron's time, by taking the diſtance of theſe ſtars from thoſe through which it now paſſes, we might determine what number of years is elapſed ſince Chiron's time. As Chiron was one of the Argonants, this would fix the time of that famons expedition, and conſequently that of the Trojan war; the two great events upon which all the ancient chronology depends. Sir Iſaac places them 500 years nearer the birth of Chriſt than other chronologers generally do.

This great man had all along enjoyed a ſettled and equal ſtate of health to the age of 80, when he began to be afflicted with an incontinence of urine. However, for the five following years, he had great intervals of eaſe, which he procured by the obſervance of a ſtrict regimen. It was then believed that he certainly had the ſtone; and when the paroxyſms were ſo violent, that large drops of ſweat ran down his face, he never uttered the leaſt complaint, or expreſſed the ſmalleſt degree of impatience; but, as ſoon as he had a moment's eaſe, would ſmile and talk with his uſual cheerfulneſs. Till then he always read and wrote ſeveral hours in a day. He had the perfect uſe of all his ſenſes and underſtanding till the day before he died, which was on the 20th of March 1726-7, in the 85th year of his age.—He lay in ſtate in the Jeruſalem chamber at Weſtminſter, and on the 28th of March his body was conveyed into Weſtminſter abbey; the pall being ſupported by the lord chancellor, the dukes of Montroſe and Roxburgh, and the earls of Pembroke, Suſſex, and Macclesfield. The biſhop of Rocheſter read the funeral office, being attended by all the clergy of the church. The corps was interred juſt at the entrance into the choir, where a noble monument is erected to his memory. Newton.

Sir Iſaac was of a middling ſtature, and in the latter part of his life ſomewhat inclined to be fat. His countenance was pleaſing, and at the ſame time venerable. He never made uſe of ſpectacles, and loſt but one tooth during his whole life.

His temper is ſaid to have been ſo equal and mild, that no accident could diſturb it. Of this the following remarkable inſtance is related. Sir Iſaac had a favourite little dog, which he called *Diamond;* and being one day called out of his ſtudy into the next room, Diamond was left behind. When Sir Iſaac returned, having been abſent but a few minutes, he had the mortification to find, that Diamond having thrown down a lighted candle among ſome papers, the nearly finiſhed labour of many years was in flames, and almoſt conſumed to aſhes. This loſs, as Sir Iſaac was then very far advanced in years, was irretrievable; yet, without once ſtriking the dog, he only rebnked him with this exclamation, "Oh! Diamond! Diamond! thou little knoweſt the miſchief thou haſt done!"

He was a great lover of peace; and would rather have choſen to remain in obſcurity, than to have the calm of life ruffled by thoſe ſtorms and diſputes which genius and learning always draw upon thoſe that are too eminent for them. In contemplating his genius, it preſently becomes a doubt, which of theſe endowments had the greateſt ſhare, ſagacity, penetration, ſtrength, or diligence: and, after all, the mark that ſeems moſt to diſtinguiſh it is, that he himſelf made the juſteſt eſtimation of it, declaring, that, if he had done the world any ſervice, it was due to nothing but induſtry and patient thought; that he kept the ſubject under conſideration conſtantly before him, and waited till the firſt dawning opened gradually, by little and little, into a full and clear light. It is ſaid, that when he had any mathematical problems or ſolutions in his mind, he would never quit the ſubject on any account. Dinner has been often three hours ready for him before he could be brought to table: that his man often ſaid, when he has been getting up in a morning, he has ſometimes begun to dreſs, and with one leg in his breeches, ſat down again on the bed, where he has remained for hours before he got his cloaths on. From his love of peace, no doubt, aroſe that unuſual kind of horror which he had for all diſputes; a ſteady unbroken attention, free from thoſe frequent recoilings inſeparably incident to others, was his peculiar felicity; he knew it, and he knew the value of it. No wonder then that controverſy was looked on as his bane. When ſome objections, haſtily made to his diſcoveries concerning light and colours, induced him to lay aſide the deſign he had of publiſhing his optic lectures; we find him reflecting on that diſpute, into which he was unavoidably drawn thereby, in theſe terms: "I blamed my own imprudence for parting with ſo real a bleſſing as my quiet, to run after a ſhadow." It is true this ſhadow, as Mr Fontenelle obſerves, did not eſcape him afterwards, nor did it coſt him that quiet which he ſo much valued, but proved as much a real happineſs to him as his quiet itſelf; yet this was a happineſs of his own making: he took a reſolution, from theſe diſputes, not to publiſh any more about that theory, till he had put it above the reach of

of controverſy, by the exacteſt experiments, and the ſtricteſt demonſtrations; and accordingly it has never been called in queſtion ſince. In the ſame temper, after he had ſent the manuſcript of his *Principia* to the Royal Society, with his conſent to the printing of it by them; yet upon Mr Hooke's injuriouſly inſiſting that himſelf had demonſtrated Kepler's problem before our author, he determined, rather than be involved again in a controverſy, to ſuppreſs the third book, and was very hardly prevailed upon to alter that reſolution. It is true, the public was thereby a gainer; that book, which is indeed no more than a corollary of ſome propoſitions in the firſt, being originally drawn up in the popular way, with a deſign to publiſh it in that form; whereas he was now convinced that it would be beſt not to let it go abroad without a ſtrict demonſtration.

After all, notwithſtanding his anxious care to avoid every occaſion of breaking his intenſe application to ſtudy, he was at a great diſtance from being ſteeped in philoſophy: on the contrary, he could lay aſide his thoughts, though engaged in the moſt intricate reſearches, when his other affairs required his attendance; and, as ſoon as he had leiſure, reſume the ſubject at the point where he had left off. This he ſeems to have done not ſo much by any extraordinary ſtrength of memory, as by the force of his inventive faculty, to which every thing opened itſelf again with eaſe, if nothing intervened to ruffle him. The readineſs of his invention made him not think of putting his memory much to the trial; but this was the offspring of a vigorous intenſeneſs of though, out of which he was but a common man. He ſpent, therefore, the prime of his age in thoſe abſtruſe reſearches, when his ſituation in a college gave him leiſure, and even while ſtudy was his proper profeſſion. But, as ſoon as he was removed to the mint, he applied himſelf chiefly to the buſineſs of that office; and ſo far quitted mathematics and philoſophy, as not to engage in any purſuits of either kind afterwards.

The amiable quality of modeſty is repreſented as ſtanding foremoſt in the character of this great man's mind and manners. It was in reality greater than can be eaſily imagined, or will be readily believed: yet it always continued ſo without any alteration, though the whole world, ſays Fontenelle, conſpired againſt it; let us add, though he was thereby robbed of his invention of fluxions. Nicholas Mercator publiſhing his *Logarithmotechnia* in 1668, where he gave the quadrature of the hyperbola by an infinite ſeries, which was the firſt appearance in the learned world of a ſeries of this ſort drawn from the particular nature of the curve, and that in a manner very new and abſtracted; Dr Barrow, then at Cambridge, where Mr Newton, then about 26 years of age, reſided, recollected, that he had met with the ſame thing in the writings of that young gentleman; and there not confined to the hyperbola only, but extended, by general forms, to all ſorts of curves, even ſuch as are mechanical; to their quadratures, their rectifications, and their centres of gravity; to the ſolids formed by their relations, and to the ſuperficies of thoſe ſolids; ſo that, when their determinations were poſſible, the ſeries ſtopped at a certain point, or at leaſt their ſums were given by ſtated rules: and, if the abſolute determinations were impoſſible, they could yet be infinitely approximated; which is the happieſt and moſt refined method, ſays Mr Fontenelle, of ſupplying the defects of human knowledge that man's imagination could poſſibly invent. To be maſter of ſo fruitful and general a theory was a mine of gold to a geometrician; but it was a greater glory to have been the diſcoverer of ſo ſurpriſing and ingenious a ſyſtem. So that Mr Newton, finding by Mercator's book, that he was in the way to it, and that others might follow in his tract, ſhould naturally have been forward to open his treaſures, and ſecure the property, which conſiſted in making the diſcovery; but he contented himſelf with his treaſure which he had found, without regarding the glory. What an idea does it give us of his unparallelled modeſty, when we ſee him declaring, that he thought Mercator had intirely diſcovered his ſecret, or that others would, before he was of a proper age for writing? His MS. upon infinite ſeries was communicated to none but Mr John Collins and the Lord Brounker; and even that had not been complied with, but for Dr Barrow, who would not ſuffer him to indulge his modeſty ſo much as he deſired.

It is further obſerved, concerning this part of his character, that he never talked either of himſelf or others, nor ever behaved in ſuch a manner as to give the moſt malicious cenſurers the leaſt occaſion even to ſuſpect him of vanity. He was candid and affable, and always put himſelf upon a level with his company. He never thought either his merit or his reputation ſufficient to excuſe him from any of the common offices of ſocial life; no ſingularities, either natural or affected, diſtinguiſhed him from other men. Though he was firmly attached to the church of England, he was averſe to the perſecution of the non-conformiſts. He judged of men by their manners; and the true ſchiſmatics, in his opinion, were the vicious and the wicked. Not that he confined his principles to natural religion, for he was thoroughly perſuaded of the truth of revelation; and amidſt the great variety of books which he had conſtantly before him, that which he ſtudied with the greateſt application was the Bible: and he underſtood the nature and force of moral certainty as well as he did that of a ſtrict demonſtration.

Sir Iſaac did not neglect the opportunities of doing good, when the revenues of his patrimony, and a profitable employment, improved by a prudent œconomy, put it in his power. We have two remarkable inſtances of his bounty and generoſity; one to Mr M'Laurin, profeſſor of mathematics at Edinburgh, to whom he offered 20l. per annum; and the other to his niece Barton, who had an annuity of 100l. per annum ſettled upon her by him. When decency upon any occaſion required expence and ſhew, he was magnificent without grudging it, and with a very good grace; at all other times, that pomp which ſeems great to low minds only, was utterly retrenched, and the expence reſerved for better uſes. He never married, and perhaps he never had leiſure to think of it. Being immerſed in profound ſtudies during the prime of his age, and afterwards engaged in an employment of great importance, and even quite taken up with the company which his merit drew to him, he was not ſenſible of any vacancy in life, nor of the want of a companion at home. He left 32,000l. at his death; but made no will, which

Mr

Newtonian Philoſophy

Mr Fontenelle tells us was becauſe he thought a legacy was no gift. As to his works, beſides what were publiſhed in his life-time, there were found after his death, among his papers, ſeveral diſcourſes upon the ſubjects of antiquity, hiſtory, divinity, chemiſtry, and mathematics, ſeveral of which were publiſhed at different times.

NEWTONIAN *Philoſophy*, the doctrine of the univerſe, and particularly of the heavenly bodies, their laws, affections, &c. as delivered by Sir Iſaac Newton.

1 Different opinions concerning this philoſophy.

The term *Newtonian philoſophy* is applied very differently; whence divers confuſed notions relating thereto.—Some authors, under this philoſophy, include all the corpuſcular philoſophy, conſidered as it now ſtands corrected and reformed by the diſcoveries and improvements made in ſeveral parts thereof by Sir Iſaac Newton. In which ſenſe it is that Graveſande calls his elements of phyſics, *Introductio ad Philoſophiam Newtonianam*. And in this ſenſe the Newtonian is the ſame with the new philoſophy; and ſtands contradiſtinguiſhed from the Carteſian, the Peripatetic, and the ancient Corpuſcular.

Others, by *Newtonian philoſophy*, mean the method or order which Sir Iſaac Newton obſerves in philoſophiſing; *viz.* the reaſoning and drawing of concluſions directly from phænomena, excluſive of all previous hypotheſes; the beginning from ſimple principles; deducing the firſt powers and laws of nature from a few ſelect phenomena, and then applying thoſe laws, &c. to account for other things. And in this ſenſe the *Newtonian philoſophy* is the ſame with the *experimental philoſophy*, and ſtands oppoſed to the ancient *Corpuſcular*.

Others, by *Newtonian philoſophy*, mean that wherein phyſical bodies are conſidered mathematically, and where geometry and mechanics are applied to the ſolution of phænomena. In which ſenſe the Newtonian is the ſame with the *mechanical* and *mathematical philoſophy*.

Others again, by *Newtonian philoſophy*, underſtand that part of phyſical knowledge which Sir Iſaac Newton has handled, improved, and demonſtrated, in his *Principia*.

Others, laſtly, by *Newtonian philoſophy*, mean the new principles which Sir Iſaac Newton has brought into philoſophy; the new ſyſtem founded thereon; and the new ſolutions of phænomena thence deduced; or that which characterizes and diſtinguiſhes his philoſophy from all others.—Which is the ſenſe wherein we ſhall chiefly conſider it.

As to the hiſtory of this philoſophy, we have nothing to add to what has been given in the preceding article. It was firſt made public in the year 1687, by the author, then a fellow of Trinity-college, Cambridge; and in the year 1713, republiſhed with conſiderable improvements.—Several authors have ſince attempted to make it plainer; by ſetting aſide many of the more ſublime mathematical reſearches, and ſubſtituting either more obvious reaſonings or experiments in lieu thereof; particularly Whiſton in his *Prælect. Phyſ. Mathemat.* Graveſande in *Element. & Inſtit.* and Dr Pemberton in his *View*.

The whole of the *Newtonian philoſophy*, as delivered by the author, is contained in his *Principia*, or *Mathematical Principles of Natural Philoſophy*. He founds his ſyſtem on the following definitions.

2 Definitions on which the philoſophy is founded.

1. The quantity of matter is the meaſure of the ſame, ariſing from its denſity and bulk conjunctly.—Thus air of a double denſity, in a double ſpace, is quadruple in quantity; in a triple ſpace, ſextuple in quantity, &c.

2. The quantity of motion is the meaſure of the ſame, ariſing from the velocity and quantity of matter conjunctly. This is evident, becauſe the motion of the whole is the motion of all its parts; and therefore in a body double in quantity, with equal velocity, the motion is double, &c.

3 *Vis inſita* defined and objected to.

3. The *vis inſita*, or innate force of matter, is a power of reſiſting, by which every body, as much as in it lies, endeavours to perſevere in its preſent ſtate, whether it be of reſt, or moving uniformly forward in a right line.—This definition is proved to be juſt, only by the difficulty we find in moving any thing out of its place; and this difficulty is by ſome reckoned to proceed only from gravity. They contend, that in thoſe caſes where we can prevent the force of gravity from acting upon bodies, this power of reſiſtance becomes inſenſible, and the greateſt quantities of matter may be put in motion by the very leaſt force. Thus there have been balances formed ſo exact, that when loaded with 200 weight in each ſcale, they would turn by the addition of a ſingle drachm. In this caſe 400 lb. of matter was put in motion by a ſingle drachm, *i. e.* by $\frac{1}{51200}$ parts of its own quantity: and even this ſmall weight, they ſay, is only neceſſary on account of the inaccuracy of the machine; ſo that we have no reaſon to ſuppoſe, that, if the friction could be entirely removed, it would take more force to move a tun weight than a grain of ſand. This objection, however, is not taken notice of by Sir Iſaac; and he beſtows on the reſiſting power abovementioned, the name of *vis inertiæ*.

4. An impreſſed force is an action exerted upon a body, in order to change its ſtate, either of reſt, or of moving uniformly forward in a right line.—This force conſiſts in the action only; and remains no longer in the body when the action is over. For a body maintains every new ſtate it acquires by its *vis inertiæ* only.

5. A centripetal force is that by which bodies are drawn, impelled, or any way tend towards a point, as to a centre.—The quantity of any centripetal force may be conſidered as of three kinds, abſolute, accelerative, and motive.

6. The abſolute quantity of a centrifugal force is the meaſure of the ſame, proportional to the efficacy of the cauſe that propagates it from the centre, through the ſpaces round about.

7. The accelerative quantity of a centripetal force is the meaſure of the ſame, proportional to the velocity which it generates in a given time.

8. The motive quantity of a centripetal force is a meaſure of the ſame, proportional to the motion which it generates in a given time.—This is always known by the quantity of a force equal and contrary to it, that is juſt ſufficient to hinder the deſcent of the body.

SCHOLIA.

4 Of time.

I. Abſolute, true, and mathematical time, of itſelf, and from its own nature, flows equably, without regard

gard to any thing external, and, by another name, is called *duration*. Relative, apparent, and common time, is some sensible and external measure of duration, whether accurate or not, which is commonly used instead of true time; such as an hour, a day, a month, a year, &c.

5 Space. II. Absolute space, in its own nature, without regard to any thing external, remains always similar and immoveable. Relative space is some moveable dimension or measure of the absolute spaces; and which is vulgarly taken for immoveable space. Such is the dimension of a subterraneous, an aerial, or celestial space, determined by its position to bodies, and which is vulgarly taken for immoveable space; as the distance of a subterraneous, an aerial, or celestial space, determined by its position in respect of the earth. Absolute and relative space are the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air which, relatively and in respect of the earth, remains always the same, will at one time be one part of the absolute space into which the air passes; at another time it will be another part of the same; and so, absolutely understood, it will be perpetually mutable.

6 Place defined. III. Place is a part of space which a body takes up; and is, according to the space, either absolute or relative. Our author says it is *part* of space; not the situation, nor the external surface of the body. For the places of equal solids are always equal; but their superficies, by reason of their dissimilar figures, are often unequal. Positions properly have no quantity, nor are they so much the places themselves as the properties of places. The motion of the whole is the same thing with the sum of the motions of the parts; that is, the translation of the whole out of its place is the same thing with the sum of the translations of the parts out of their places: and therefore the place of the whole is the same thing with the sum of the places of the parts; and for that reason it is internal, and in the whole body.

7 Of motion. IV. Absolute motion is the translation of a body from one absolute place into another, and relative motion the translation from one relative place into another. Thus, in a ship under sail, the relative place of a body is that part of the ship which the body possesses, or that part of its cavity which the body fills, and which therefore moves together with the ship; and relative rest is the continuance of the body in the same part of the ship, or of its cavity. But real absolute rest is the continuance of the body in the same part of that immoveable space in which the ship itself, its cavity, and all that it contains, is moved. Wherefore, if the earth is really at rest, the body which relatively rests in the ship will really and absolutely move with the same velocity which the ship has on the earth. But if the earth also moves, the true and absolute motion of the body will arise, partly from the true motion of the earth in immoveable space; partly from the relative motion of the ship on the earth: and if the body moves also relatively in the ship, its true motion will arise partly from the true motion of the earth in immoveable space, and partly from the relative motions as well of the ship on the earth, as of the body in the ship; and from these relative motions will arise the relative motion of the body on the earth. As if that part of the earth where the ship is, was truly moved towards the east, with a velocity of 10010 parts; while the ship itself with a fresh gale is carried towards the west, with a velocity expressed by 10 of these parts; but a sailor walks in the ship towards the east with one part of the said velocity: then the sailor will be moved truly and absolutely in immoveable space towards the east with a velocity of 1001 parts; and relatively on the earth towards the west, with a velocity of 9 of those parts.

Absolute time, in astronomy, is distinguished from relative, by the equation or correction of the vulgar time. For the natural days are truely unequal, though they are commonly considered as equal, and used for a measure of time: astronomers correct this inequality for their more accurate deducing of the celestial motions. It may be that there is no such thing as an equable motion whereby time may be accurately measured. All motions may be accelerated or retarded; but the true or equable progress of absolute time is liable to no change. The duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all; and therefore ought to be distinguished from what are only sensible measures thereof, and out of which we collect it by means of the astronomical equation. The necessity of which equation for determining the times of a phenomenon is evinced, as well from the experiments of the pendulum-clock, as by eclipses of the satellites of Jupiter.

As the order of the parts of time is immutable, so also is the order of the parts of space. Suppose those parts to be moved out of their places, and they will be moved (if we may be allowed the expression) out of themselves. For times and spaces are, as it were, the places of themselves as of all other things. All things are placed in time as to order of succession; and in space as to order of situation. It is from their essence or nature that they are places; and that the primary places of things should be moveable, is absurd. These are therefore the absolute places; and translations out of those places are the only absolute motions. 8 Immutability of time and space.

But because the parts of space cannot be seen, or distinguished from one another by the senses, therefore in their stead we use sensible measures of them. For, from the positions and distances of things from any body, considered as immoveable, we define all places; and then with respect to such places, we estimate all motions, considering bodies as transferred from some of those places into others. And so, instead of absolute places and motions, we use relative ones; and that without any inconvenience in common affairs: but in philosophical disquisitions we ought to abstract from our senses, and consider things themselves distinct from what are only sensible measures of them. For it may be, that there is no body really at rest, to which the places and motions of others may be referred.

But we may distinguish rest and motion, absolute and relative, one from the other by their properties, causes, and effects. It is a property of rest, that bodies really at rest do rest in respect of each other. And therefore, as it is possible, that, in the remote regions

gions of the fixed ſtars, or perhaps far beyond them, there may be ſome body abſolutely at reſt, but impoſſible to know from the poſition of bodies to one another in our regions, whether any of theſe do keep the ſame poſition to that remote body; it follows, that abſolute reſt cannot be determined from the poſition of bodies in our regions.

9
Of the motion of different bodies with reſpect to one another.

It is a property of motion, that the parts which retain given poſitions to their wholes do partake of the motions of their wholes. For all parts of revolving bodies endeavour to recede from the axis of motion; and the impetus of bodies moving forwards ariſes from the joint impetus of all the parts. Therefore if ſurrounding bodies are moved, thoſe that are relatively at reſt within them will partake of their motion. Upon which account the true and abſolute motion of a body cannot be determined by the tranſlation of it from thoſe only which ſeem to reſt; for the external bodies ought not only to appear at reſt, but to be really at reſt. For otherwiſe all included bodies, beſide their tranſlation from near the ſurrounding ones, partake likewiſe of their true motions; and though that tranſlation was not made, they would not really be at reſt, but only ſeem to be ſo. For the ſurrounding bodies ſtand in the like relation to the ſurrounded, as the exterior part of a whole does to the interior, or as the ſhell does to the kernel; but if the ſhell moves, the kernel will alſo move, as being part of the whole, without any removal from near the ſhell.

A property near akin to the preceding is, that if a place is moved, whatever is placed therein moves along with it; and therefore a body which is moved from a place in motion, partakes alſo of the motion of its place. Upon which account all motions from places in motion, are no other than parts of entire and abſolute motions; and every entire motion is compoſed out of the motion of the body out of its firſt place, and the motion of this place out of its place; and ſo on, until we come to ſome immoveable place, as in the above-mentioned example of the ſailor. Wherefore entire and abſolute motions can be no otherwiſe determined than by immoveable places. Now, no other places are immoveable but thoſe that from infinity to infinity do all retain the ſame given poſitions one to another; and upon this account muſt ever remain unmoved, and do thereby conſtitute what we call *immoveable ſpace*.

The cauſes by which true and relative motions are diſtinguiſhed one from the other, are the forces impreſſed upon bodies to generate motion. True motion is neither generated nor altered, but by ſome force impreſſed upon the body moved: but relative motion may be generated or altered without any force impreſſed upon the body. For it is ſufficient only to impreſs ſome force on other bodies with which the former is compared, that, by their giving way, that relation may be changed, in which the relative reſt or motion of the other body did conſiſt. Again, true motion ſuffers always ſome change from any force impreſſed upon the moving body; but relative motion does not neceſſarily undergo any change by ſuch force. For if the ſame forces are likewiſe impreſſed on thoſe other bodies with which the compariſon is made, that the relative poſition may be preſerved; then that condition will be preſerved; in which the relative motion conſiſts. And therefore any relative motion may be changed when the true motion remains unaltered, and the relative may be preſerved when the true motion ſuffers ſome change. Upon which account true motion does by no means conſiſt in ſuch relations. 10

Abſolute and relative motion diſtinguiſhed.

The effects which diſtinguiſh abſolute from relative motion are, the forces of receding from the axis of circular motion. For there are no ſuch forces in a circular motion purely relative: but, in a true and abſolute circular motion, they are greater or leſs according to the quantity of the motion. If a veſſel, hung by a long cord, is ſo often turned about that the cord is ſtrongly twiſted, then filled with water, and let go, it will be whirled about the contrary way; and while the cord is untwiſting itſelf, the ſurface of the water will at firſt be plain, as before the veſſel began to move; but the veſſel, by gradually communicating its motion to the water, will make it begin ſenſibly to revolve, and recede by little and little from the middle, and aſcend to the ſides of the veſſel, forming itſelf into a concave figure; and the ſwifter the motion becomes, the higher will the water riſe, till at laſt, performing its revolutions in the ſame times with the veſſel, it becomes relatively at reſt in it. This aſcent of the water ſhews its endeavour to recede from the axis of its motion; and the true and abſolute circular motion of the water, which is here directly contrary to the relative, diſcovers itſelf, and may be meaſured by this endeavour. At firſt, when the relative motion in the water was greateſt, it produced no endeavour to recede from the axis; the water ſhewed no tendency to the circumference, nor any aſcent towards the ſides of the veſſel, but remained of a plain ſurface; and therefore its true circular motion had not yet begun. But afterwards, when the relative motion of the water had decreaſed, the aſcent thereof towards the ſides of the veſſel, proved its endeavour to recede from the axis; and this endeavour ſhewed the real circular motion of the water perpetually increaſing, till it had acquired its greateſt quantity, when the water reſted relatively in the veſſel. And therefore this endeavour does not depend upon any tranſlation of the water in reſpect of the ambient bodies; nor can true circular motion be defined by ſuch tranſlations. There is only one real circular motion of any one revolving body, correſponding to only one power of endeavouring to recede from its axis of motion, as its proper and adequate effect: but relative motions in one and the ſame body are innumerable, according to the various relations it bears to external bodies; and, like other relations, are altogether deſtitute of any real effect, otherwiſe than they may perhaps participate of that only true motion. And therefore, in the ſyſtem which ſuppoſes that our heavens, revolving below the ſphere of the fixed ſtars, carry the planets along with them, the ſeveral parts of thoſe heavens and the planets, which are indeed relatively at reſt in their heavens, do yet really move. For they change their poſition one to another, which never happens to bodies truly at reſt; and being carried together with the heavens, participate of their motions, and, as parts of revolving wholes, endeavour to recede from the axis of their motion.

Wherefore relative quantities are not the quantities themſelves whoſe names they bear, but thoſe ſenſible mea-

meaſures of them, either accurate or inaccurate, which are commonly uſed inſtead of the meaſured quantities themſelves. And then, if the meaning of words is to be determined by their uſe, by the names *time*, *ſpace*, *place*, and *motion*, their meaſures are properly to be underſtood; and the expreſſion will be unuſual and purely mathematical, if the meaſured quantities themſelves are meant.

It is indeed a matter of great difficulty to diſcover, and effectually to diſtinguiſh, the true motions of particular bodies from thoſe that are only apparent: becauſe the parts of that immoveable ſpace in which thoſe motions are performed, do by no means come under the obſervation of our ſenſes. Yet we have ſome things to direct us in this intricate affair; and theſe ariſe partly from the apparent motions which are the difference of the true motions, partly from the forces which are the cauſes and effects of the true motions. For inſtance, if two globes, kept at a given diſtance one from the other by means of a cord that connects them, were revolved about their common centre of gravity; we might, from the tenſion of the cord, diſcover the endeavour of the globes to recede from the axis of motion, and from thence we might compute the quantity of their circular motions. And then, if any equal forces ſhould be impreſſed at once on the alternate faces of the globes to augment or diminiſh their circular motions, from the increaſe or decreaſe of the tenſion of the cord we might infer the increment or decrement of their motions; and thence would be found on what faces thoſe forces ought to be impreſſed, that the motions of the globes might be moſt augmented; that is, we might diſcover their hindermoſt faces, or thoſe which follow in the circular motion. But the faces which follow being known, and conſequently the oppoſite ones that precede, we ſhould likewiſe know the determination of their motions. And thus we might find both the quantity and determination of this circular motion, even in an immenſe vacuum, where there was nothing external or ſenſible, with which the globes might be compared. But now, if in that ſpace ſome remote bodies were placed that kept always a given poſition one to another, as the fixed ſtars do in our regions; we could not indeed determine from the relative tranſlation of the globes among thoſe bodies, whether the motion did belong to the globes or to the bodies. But if we obſerved the cord, and found that its tenſion was that very tenſion which the motions of the globes required, we might conclude the motion to be in the globes, and the bodies to be at reſt; and then, laſtly, from the tranſlation of the globes among the bodies, we ſhould find the determination of their motions.

Having thus explained himſelf, Sir Iſaac propoſes to ſhow how we are to collect the true motions from their cauſes, effects, and apparent differences; and *vice verſa*, how, from the motions, either true or apparent, we may come to the knowledge of their cauſes and effects. In order to this, he lays down the following axioms or laws of motion.

12 Laws of motion.

1. Every body perſeveres in its ſtate of reſt, or of uniform motion in a right line, unleſs it is compelled to change that ſtate by forces impreſſed upon it.—Sir Iſaac's proof of this action is as follows: "Projectiles perſevere in their motions, ſo far as they are not retarded by the reſiſtance of the air, or impelled downwards by the force of gravity. A top, whoſe parts, by their coheſion, are perpetually drawn aſide from rectilinear motions, does not ceaſe its rotation otherwiſe than as it is retarded by the air. The greater bodies of the planets and comets, meeting with leſs reſiſtance in more free ſpaces, preſerve their motions, both progreſſive and circular, for a much longer time."—Notwithſtanding this demonſtration, however, the axiom hath been violently diſputed. It hath been argued, that bodies continue in their ſtate of motion becauſe they are ſubjected to the continual impulſe of an inviſible and ſubtile fluid, which always pours in from behind, and of which all places are full. They affirm that motion is as natural to this fluid as reſt is to all other matter. They ſay, moreover, that it is impoſſible we can know in what manner a body would be influenced by moving forces if it was entirely deſtitute of gravity. According to what we can obſerve, the momentum of a body, or its tendency to move, depends very much on its gravity. A heavy cannon-ball will fly to a much greater diſtance than a light one, though both are actuated by an equal force. It is by no means clear therefore, that a body totally deſtitute of gravity would have any proper momentum of its own; and if it had no momentum, it could not continue its motion for the ſmalleſt ſpace of time after the moving power was withdrawn. Some have imagined that matter was capable of beginning motion of itſelf, and conſequently that the axiom was falſe; becauſe we ſee plainly that matter in ſome caſes hath a tendency to change from a ſtate of motion to a ſtate of reſt, and from a ſtate of reſt to a ſtate of motion. A paper appeared on this ſubject in the firſt volume of the Edinburgh Phyſical and Literary Eſſays; but the hypotheſis never gained any ground.

13 Objections to the firſt law.

2. The alteration of motion is ever proportional to the motive force impreſſed; and is made in the direction of the right line in which that force is impreſſed. Thus, if any force generates a certain quantity of motion, a double force will generate a double quantity, whether that force be impreſſed all at once, or in ſucceſſive moments.

14 Objections to the third law.

3. To every action there is always oppoſed an equal re-action: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.—This axiom is alſo diſputed by many. In the abovementioned paper in the Phyſical Eſſays, the author endeavours to make a diſtinction between re-action and reſiſtance; but this cannot be ſufficiently explained, and therefore the hypotheſis hath not been adopted. Others grant that Sir Iſaac's axiom is very true in reſpect to terreſtrial ſubſtances; but they affirm, that, in theſe, both action and re-action are the effects of gravity. Subſtances void of gravity would have no momentum; and without this they could not act; they would be moved by the leaſt force, and therefore could not reſiſt or re-act. If therefore there is any fluid which is the cauſe of gravity, though ſuch fluid could act upon terreſtrial ſubſtances, yet theſe could not re-act upon it; becauſe they have no force of their own, but depend entirely upon it for their momentum. In this manner, ſay they, we may conceive that the planets circulate, and all the operations of nature are carried on by means of a ſubtile fluid; which being per-

fectly active, and the rest of matter altogether passive, there is neither resistance, nor loss of motion.

From the preceding axiom Sir Isaac draws the following corollaries.

1. A body by two forces conjoined will describe the diagonal of a parallelogram in the same time that it would describe the sides by those forces apart.

2. Hence we may explain the composition of any one direct force out of any two oblique ones, *viz.* by making the two oblique forces the sides of a parallelogram, and the direct one the diagonal.

3. The quantity of motion, which is collected by taking the sum of the motions directed towards the same parts, and the difference of those that are directed to contrary parts, suffers no change from the action of bodies among themselves; because the motion which one body loses is communicated to another: and if we suppose friction and the resistance of the air to be absent, the motion of a number of bodies which mutually impelled one another would be perpetual, and its quantity always equal.

4. The common centre of gravity of two or more bodies does not alter its state of motion or rest by the actions of the bodies among themselves; and therefore the common centre of gravity of all bodies acting upon each other (excluding outward actions and impediments) is either at rest, or moves uniformly in a right line.

5. The motions of bodies included in a given space are the same among themselves, whether that space is at rest, or moves uniformly forward in a right line without any circular motion. The truth of this is evidently shewn by the experiment of a ship; where all motions happen after the same manner, whether the ship is at rest, or proceeds uniformly forward in a straight line.

6. If bodies, any how moved among themselves, are urged in the direction of parallel lines by equal accelerative forces, they will all continue to move among themselves, after the same manner as if they had been urged by no such forces.

The whole of the mathematical part of the Newtonian philosophy depends on the following lemmas; of which the first is the principal.

Lem. I. Quantities, and the ratios of quantities, which in any finite time converge continually to equality, and before that time approach nearer the one to the other than by any given difference, become ultimately equal. If you deny it; suppose them to be ultimately unequal, and let D be their ultimate difference. Therefore they cannot approach nearer to equality than by that given difference D; which is against the supposition.

16 Objections to the first lemma.

Concerning the meaning of this lemma philosophers are not agreed; and unhappily it is the very fundamental position on which the whole of the system rests. Many objections have been raised to it by people who supposed themselves capable of understanding it. They say, that it is impossible we can come to an end of any infinite series, and therefore that the word *ultimate* can in this case have no meaning. In some cases the lemma is evidently false. Thus, suppose there are two quantities of matter A and B, the one containing half a pound, and the other a third part of one. Let both be continually divided by 2; and though their ratio, or the proportion of the one to the other, doth not vary, yet the difference between them perpetually becomes less, as well as the quantities themselves, until both the difference and quantities themselves become less than any assignable quantity; yet the difference will never totally vanish, nor the quantities become equal, as is evident from the two following series.

$$\frac{1}{2}\ \frac{1}{4}\ \frac{1}{8}\ \frac{1}{16}\ \frac{1}{32}\ \frac{1}{64}\ \frac{1}{128}\ \frac{1}{256}\ \frac{1}{512}\ \frac{1}{1024},\ \&c.$$
$$\frac{1}{3}\ \frac{1}{6}\ \frac{1}{12}\ \frac{1}{24}\ \frac{1}{48}\ \frac{1}{96}\ \frac{1}{192}\ \frac{1}{384}\ \frac{1}{768}\ \frac{1}{1536},\ \&c.$$
$$\text{Diff. } \frac{1}{6}\ \frac{1}{12}\ \frac{1}{24}\ \frac{1}{48}\ \frac{1}{96}\ \frac{1}{192}\ \frac{1}{384}\ \frac{1}{768}\ \frac{1}{1536}\ \frac{1}{3072},\ \&c.$$

Thus we see, that though the difference is continually diminishing, and that in a very large proportion, there is no hope of its vanishing, or the quantities becoming equal. In like manner, let us take the proportions or ratios of quantities, and we shall be equally unsuccessful. Suppose two quantities of matter, one containing 8 and the other 10 pounds; these quantities already have to each other the ratio of 8 to 10, or of 4 to 5; but let us add 2 continually to each of them, and though the ratios continually come nearer to that of equality, it is in vain to hope for a perfect coincidence. Thus,

$$8\ \ 10\ \ 12\ \ 14\ \ 16\ \ 18\ \ 20\ \ 22\ \ 24,\ \&c.$$
$$10\ \ 12\ \ 14\ \ 16\ \ 18\ \ 20\ \ 22\ \ 24\ \ 26,\ \&c.$$
$$\text{Ratio } \frac{4}{5}\ \frac{5}{6}\ \frac{6}{7}\ \frac{7}{8}\ \frac{8}{9}\ \frac{0}{10}\ \frac{10}{11}\ \frac{11}{12}\ \frac{12}{13},\ \&c.$$

For this and his other lemmas Sir Isaac makes the following apology. 17 Answered.

"These lemmas are premised, to avoid the tediousness of deducing perplexed demonstrations *ad absurdum*, according to the method of ancient geometers. For demonstrations are more contracted by the method of indivisibles: but because the hypothesis of indivisibles seems somewhat harsh, and therefore that method is reckoned less geometrical, I chose rather to reduce the demonstrations of the following propositions to the first and last sums and ratios of nascent and evanescent quantities, that is, to the limits of those sums and ratios; and so to premise, as short as I could, the demonstrations of those limits. For hereby the same thing is performed as by the method of indivisibles; and now those principles being demonstrated, we may use them with more safety. Therefore, if hereafter I should happen to consider quantities as made up of particles, or should use little curve lines for right ones; I would not be understood to mean indivisibles, but evanescent divisible quantities; not the sums and ratios of determinate parts, but always the limits of sums and ratios; and that the force of such demonstrations always depends on the method laid down in the foregoing lemmas.

"Perhaps it may be objected, that there is no ultimate proportion of evanescent quantities, because the proportion before the quantities have vanished, is not the ultimate, and, when they are vanished, is none. But by the same argument it may be alleged, that a body arriving at a certain place, and there stopping, has no ultimate velocity; because the velocity before the body comes to the place is not its ultimate velocity; when it is arrived, it has none. But the answer is easy: for by the ultimate velocity is meant that with which the body is moved, neither before it arrives at its place and the motion ceases, nor after; but at the very instant it arrives; that is, that velocity with which the body arrives at its last place, and with which the motion ceases. And in like manner, by the ultimate ratio of evanescent quantities is to be under-

underftood the ratio of the quantities, not before they vanifh, nor afterwards, but with which they vanifh. In like manner, the firft ratio of nafcent quantities is that with which they begin to be. And the firft or laft fum is that with which they begin and ceafe to be (or to be augmented and diminifhed). There is a limit which the velocity at the end of the motion may attain, but not exceed; and this is the ultimate velocity. And there is the like limit in all quantities and proportions that begin and ceafe to be. And, fince fuch limits are certain and definite, to determine the fame is a problem ftrictly geometrical. But whatever is geometrical we may be allowed to make ufe of in determining and demonftrating any other thing that is likewife geometrical.

"It may be alfo objected, that if the ultimate ratios of evanefcent quantities are given, their ultimate magnitudes will alfo be given; and fo all quantities will confift of indivifibles, which is contrary to what Euclid has demonftrated concerning incommenfurables, in the 10th book of his Elements. But this objection is founded on a falfe fuppofition. For thofe ultimate ratios with which quantities vanifh are not truly the ratios of ultimate quantities, but limits towards which the ratios of quantities decreafing continually approach."

LEM. II. If in any figure A a c E (Pl. CCIV. fig. 2.) terminated by the right line Aa, AE, and the curve a c E, there be infcribed any number of parallelograms Ab, Bc, Cd, &c. comprehended under equal bafes AB, BC, CD, &c. and the fides Bb, Cc, Dd, &c. parallel to one fide Aa of the figure; and the parallelograms a K b l, b L c m, c M d n, &c. are completed. Then if the breadth of thofe parallelograms be fuppofed to be diminifhed, and their number augmented *in infinitum*; the ultimate ratios which the infcribed figure A K b L c M d D, the circumfcribed figure A a l b m c n d o E, and curvilinear figure A a b c d E, will have to one another, are ratios of equality. —For the difference of the infcribed and circumfcribed figures is the fum of the parallelograms K l, L m, M n, D o; that is, (from the equality of all their bafes), the rectangle under one of their bafes K b, and the fum of their altitudes A a, that is, the rectangle A B l a. But this rectangle, becaufe its breadth AB is fuppofed diminifhed *in infinitum*, becomes lefs than any given fpace. And therefore, by lem. 1. the figures infcribed and circumfcribed become ultimately equal the one to the other; and much more will the intermediate curvilinear figure be ultimately equal to either.

LEM. III. The fame ultimate ratios are alfo ratios of equality, when the breadths AB, BC, DC, &c. of the parallelograms are unequal, and are all diminifhed *in infinitum*.—The demonftration of this differs but little from that of the former.

In his fucceeding lemmas, Sir Ifaac goes on to prove, in a manner fimilar to the above, that the ultimate ratios of the fine, chord, and tangent of arcs infinitely diminifhed, are ratios of equality, and therefore that in all our reafonings about thefe we may fafely ufe the one for the other:—that the ultimate form of evanefcent triangles made by the arc, chord, and tangent, is that of fimilitude, and their ultimate ratio is that of equality; and hence, in reafonings about ultimate ratios, we may fafely ufe thefe triangles for each other, whether made with the fine, the arc, or the tangent.—He then fhews fome properties of the ordinates of curvilinear figures; and proves that the fpaces which a body defcribes by any finite force urging it, whether that force is determined and immutable, or is continually augmented or continually diminifhed, are, in the very beginning of the motion, one to the other in the duplicate ratio of the powers. And laftly, having added fome demonftrations concerning the evanefcence of angles of contact, he proceeds to lay down the mathematical part of his fyftem, and which depends on the following theorems.

THEOR. I. The areas which revolving bodies defcribe by radii drawn to an immoveable centre of force, lie in the fame immoveable planes, and are proportional to the times in which they are defcribed.—For, fuppofe the time to be divided into equal parts, and in the firft part of that time, let the body by its innate force defcribe the right line AB (fig. 3.); in the fecond part of that time, the fame would, by law 1. if not hindered, proceed directly to c along the line Bc = AB; fo that by the radii AS, BS, c S, drawn to the centre, the equal areas ASB, B S c, would be defcribed. But, when the body is arrived at B, fuppofe the centripetal force acts at once with a great impulfe, and, turning afide the body from the right line B c, compels it afterwards to continue its motion along the right line BC. Draw c C parallel to BS, meeting BC in C; and at the end of the fecond part of the time, the body, by cor. 1. of the laws, will be found in C, in the fame plane with the triangle ASB. Join SC; and becaufe SB and c C are parallel, the triangle SBC will be equal to the triangle SBC, and therefore alfo to the triangle SAB. By the like argument, if the centripetal force acts fucceffively in C, D, E, &c. and makes the body in each fingle particle of time to defcribe the right lines CD, DE, EF, &c. they will all lie in the fame plane; and the triangle SCD will be equal to the triangle SBC, and SDE to SCD, and SEF to SDE. And therefore, in equal times, equal areas are defcribed in one immoveable plane; and, by compofition, any fums SADS, SAFS, of thofe areas are, one to the other, as the times in which they are defcribed. Now, let the number of thofe triangles be augmented, and their fize diminifhed *in infinitum*; and then, by the preceding lemmas, their ultimate perimeter ADF will be a curve line: and therefore the centripetal force by which the body is perpetually drawn back from the tangent of this curve will act continually; and any defcribed areas SADS, SAFS, which are always proportional to the times of defcription, will, in this cafe alfo, be proportional to thofe times. Q. E. D.

COR. 1. The velocity of a body attracted towards an immoveable centre, in fpaces void of refiftance is reciprocally as the perpendicular let fall from that centre on the right line which touches the orbit. For the velocities in thefe places A, B, C, D, E, are as the bafes AB, BC, DE, EF, of equal triangles; and thefe bafes are reciprocally as the perpendiculars let fall upon them.

COR. 2. If the chords AB, BC, of two arcs fucceffively defcribed in equal times by the fame body, in fpaces void of refiftance, are completed into a pa-

parallelogram ABCV, and the diagonal BV of this parallelogram, in the pofition which it ultimately acquires when thofe arcs are diminifhed *in infinitum* is produced both ways, it will pafs through the centre of force.

COR. 3. If the chords AB, BC, and DE, EF, of arcs defcribed in equal times, in fpaces void of refiftance are completed into the parallelograms ABCV, DEFZ, the forces in B and E are one to the other in the ultimate ratio of the diagonals BV, EZ, when thofe arcs are diminifhed *in infinitum*. For the motions BC and EF of the body (by cor. 1. of the laws), are compounded of the motions B*c*, BV and E*f*, EZ; but BV and EZ, which are equal to C*c*= and F*f*, in the demonftration of this propofition, were generated by the impulfes of the centripetal force in B and E, and are therefore proportional to thofe impulfes.

COR. 4. The forces by which bodies, in fpaces void of refiftance, are drawn back from rectilinear motions, and turned into curvilinear orbits, are one to another as the verfed fines of arcs defcribed in equal times; which verfed fines tend to the centre of force, and bifect the chords when thefe arcs are diminifhed to infinity. For fuch verfed fines are the halfs of the diagonals mentioned in cor. 3.

COR. 5. And therefore thofe forces are to the force of gravity, as the faid verfed fines to the verfed fines perpendicular to the horizon of thofe parabolic arcs which projectiles defcribe in the fame time.

COR. 6. And the fame things do all hold good (by cor. 5. of the laws) when the planes in which the bodies are moved, together with the centres of force, which are placed in thofe planes, are not at reft, but move uniformly forward in right lines.

THEOR. II. Every body that moves in any curve line defcribed in a plane, and, by a radius drawn to a point either immoveable or moving forward with an uniform rectilinear motion, defcribes about that point areas proportional to the times, is urged by a centripetal force directed to that point.

CASE I. For every body that moves in a curve line is (by law 1.) turned afide from its rectilinear courfe by the action of fome force that impels it; and that force by which the body is turned off from its rectilinear courfe, and made to defcribe in equal times the leaft equal triangles SAB, SBC, SCD, &c. about the immoveable point S, (by Prop. 40. E. 1. and law 2.) acts in the place B according to the direction of a line parallel to C; that is, in the direction of the line BS; and in the place C according to the direction of a line parallel to d D, that is, in the direction of the line CS, &c.; and therefore acts always in the direction of lines tending to the immoveable point S. Q. E. D.

CASE II. And (by cor. 5. of the laws) it is indifferent whether the fuperficies in which a body defcribes a curvilinear figure be quiefcent, or moves together with the body, the figure defcribed, and its point S, uniformly forward in right lines.

COR. 1. In non-refifting fpaces or mediums, if the areas are not proportional to the times, the forces are not directed to the point in which the radii meet; but deviate therefrom *in confequentia*, or towards the parts to which the motion is directed, if the defcription of the areas is accelerated; but *in antecedentia* if retarded.

COR. 2. And even in refifting mediums, if the defcription of the areas is accelerated, the directions of the forces deviate from the point in which the radii meet, towards the parts to which the motion tends.

SCHOLIUM.

A body may be urged by a centripetal force compounded of feveral forces. In which cafe the meaning of the propofition is, that the force which refults out of all tends to the point S. But if any force acts perpetually in the direction of lines perpendicular to the defcribed furface, this force will make the body to deviate from the plane of its motion, but will neither augment nor diminifh the quantity of the defcribed furface; and is therefore not to be neglected in the compofition of forces.

THEOR. III. Every body that, by a radius drawn to the centre of another body, howfoever moved, defcribes areas about that centre proportional to the times, is urged by a force compounded out of the centripetal forces tending to that other body, and of all the accelerative force by which that other body is impelled.—The demonftration of this is a natural confequence of the theorem immediately preceding.

Hence, if the one body L, by a radius drawn to the other body T, defcribes areas proportional to the times, and from the whole force by which the firft body L is urged, (whether that force is fimple, or, according to cor. 2. of the laws, componnded out of feveral forces), we fubduct that whole accelerative force by which the other body is urged; the whole remaining force by which the firft body is urged will tend to the other body T, as its centre.

And *vice verfa*, if the remaining force tends nearly to the other body T, thofe areas will be nearly proportional to the times.

If the body L, by a radius drawn to the other body T, defcribes areas, which, compared with the times, are very unequal; and that other body T be either at reft, or moves uniformly forward in a right line, the action of the centripetal force tending to that other body T is either none at all, or it is mixed and combined with very powerful actions of other forces: and the whole force compounded of them all, if they are many, is directed to another (immoveable or moveable) centre. The fame thing obtains when the other body is actuated by any other motion whatever; provided that centripetal force is taken which remains after fubducting that whole force acting upon that other body T.

SCHOLIUM.

Becaufe the equable defcription of areas indicates that a centre is refpected by that force with which the body is moft affected, and by which it is drawn back from its rectilinear motion, and retained in its orbit, we may always be allowed to ufe the equable defcription of areas as an indication of a centre about which all circular motion is performed in free fpaces.

THEOR. IV. The centripetal forces of bodies which by equable motions defcribe different circles, tend to the centres of the fame circles; and are one to the other as the fquares of the arcs defcribed in equal times applied to the radii of circles,—For thefe forces tend

Newtonian Philosophy

tend to the centres of the circles, (by theor. 2. and cor. 2. theor. 1.) and are to one another as the verfed fines of the leaft arcs defcribed in equal times, (by cor. 4. theor. 1.) that is, as the fquares of the fame arcs applied to the diameters of the circles, by one of the lemmas; and therefore, fince thofe arcs are as arcs defcribed in any equal times, and the diameters are as the radii, the forces will be as the fquares of any arcs defcribed in the fame time, applied to the radii of the circles. Q. E. D.

Cor. 1. Therefore, fince thofe arcs are as the velocities of the bodies, the centripetal forces are in a ratio compounded of the duplicate ratio of the velocities directly, and of the fimple ratio of the radii inverfely.

Cor. 2. And fince the periodic times are in a ratio compounded of the ratio of the radii directly, and the ratio of the velocities inverfely; the centripetal forces are in a ratio compounded of the ratio of the radii directly, and the duplicate ratio of the periodic times inverfely.

Cor. 3. Whence, if the periodic times are equal, and the velocities therefore as the radii, the centripetal forces will be alfo as the radii; and the contrary.

Cor. 4. If the periodic times and the velocities are both in the fubduplicate ratio of the radii, the centripetal forces will be equal among themfelves; and the contrary.

Cor. 5. If the periodic times are as the radii, and therefore the velocities equal, the centripetal forces will be reciprocally as the radii; and the contrary.

Cor. 6. If the periodic times are in the fefquiplicate ratio of the radii, and therefore the velocities reciprocally in the fubduplicate ratio of the radii, the centripetal forces will be in the duplicate ratio of the radii inverfely; and the contrary.

Cor. 7. And univerfally, if the periodic time is as any power R^n of the radius R, and therefore the velocity reciprocally as the power R^{n-1} of the radius, the centripetal force will be reciprocally as the power R^{2n-2} of the radius; and the contrary.

Cor. 8. The fame things all hold concerning the times, the velocities, and forces, by which bodies defcribe the fimilar parts of any fimilar figures, that have their centres in a fimilar pofition within thofe figures, as appears by applying the demonftrations of the preceding cafes to thofe. And the application is eafy, by only fubftituting the equable defcription of areas in the place of equable motion, and ufing the diftances of the bodies from the centres inftead of the radii.

Cor. 9. From the fame demonftration it likewife follows, that the arc which a body uniformly revolving in a circle by means of a given centripetal force defcribes in any time, is a mean proportional between the diameter of the circle, and the fpace which the fame body, falling by the fame given force, would defcend through in the fame given time.

"By means of the preceding propofition and its corollaries, (fays Sir Ifaac), we may difcover the proportion of a centripetal force to any other known force, fuch as that of gravity. For if a body by means of its gravity revolves in a circle concentric to the earth, this gravity is the centripetal force of that body. But from the defcent of heavy bodies, the time of one entire revolution, as well as the arc defcribed in any given time, is given (by cor. 9. of this theorem). And by fuch propofitions Mr Huygens, in his excellent book *De Horologio Ofcillatorio*, has compared the force of gravity with the centrifugal forces of revolving bodies.

The preceding propofition may alfo be demonftrated in the following manner. In any circle fuppofe a polygon to be infcribed of any number of fides. And if a body, moved with a given velocity along the fides of the polygon, is reflected from the circle at the feveral angular points; the force with which, at every reflection, it ftrikes the circle will be as its velocity: and therefore the fum of the forces, in a given time, will be as that velocity and the number of reflections conjunctly; that is, (if the fpecies of the polygon be given), as the length defcribed in that given time, and increafed or diminifhed in the ratio of the fame length to the radius of the circle; that is, as the fquare of that length applied to the radius; and therefore, if the polygon, by having its fides diminifhed *in infinitum*, coincides with the circle, as the fquare of the arc defcribed in a given time applied to the radius. This is the centrifugal force, with which the body impels the circle; and to which the contrary force, wherewith the circle continually repels the body towards the centre, is equal.

On thefe principles hangs the whole of Sir Ifaac Newton's mathematical philofophy. He now fhews how to find the centre to which the forces impelling any body are directed, having the velocity of the body given: and finds the centrifugal force to be always as the verfed fine of the nafcent arc directly, and as the fquare of the time inverfely; or directly as the fquare of the velocity, and inverfely as the chord of the nafcent arc. From thefe premiffes he deduces the method of finding the centripetal force directed to any given point when the body revolves in a circle; and this whether the central point is near or at an immenfe diftance; fo that all the lines drawn from it may be taken for parallels. The fame thing he fhews with regard to bodies revolving in fpirals, ellipfes, hyperbolas, or parabolas.—Having the figures of the orbits given, he fhews alfo how to find the velocities and moving powers; and, in fhort, folves all the moft difficult problems relating to the celeftial bodies with an aftonifhing degree of mathematical fkill. Thefe problems and demonftrations are all contained in the firft book of the *Principia*: but to give an account of them here would exceed our limits; neither would many of them be intelligible, excepting to firft-rate mathematicians.

18 Rules for philofophical reafoning.

In the fecond book Sir Ifaac treats of the properties of fluids, and their powers of refiftance; and here he lays down fuch principles as entirely overthrow the doctrine of Des Cartes's vortices, which was the fafhionable fyftem in his time. In the third book, he begins particularly to treat of the natural phenomena, and apply to them the mathematical principles formerly demonftrated; and, as a neceffary preliminary to this part, he lays down the following rules for reafoning in natural philofophy.

1. We are to admit no more caufes of natural things

things than fuch as are both true and fufficient to explain their natural appearances.

2. Therefore to the fame natural effects we muft always affign, as far as poffible, the fame caufes.

3. The qualities of bodies which admit neither intenfion nor remiffion of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be efteemed the univerfal qualities of all bodies whatfoever.

4. In experimental philofophy, we are to look upon propofitions collected by general induction from phenomena as accurately or very nearly true, notwithftanding any contrary hypothefes that may be imagined, till fuch time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.

The phenomena firft confidered, are, 1. That the fatellites of Jupiter by radii drawn to the centre of their primary, defcribe areas proportional to the times of their defcription; and that their periodic times, the fixed ftars being at reft, are in the fefquiplicate ratio of their diftances from its centre. 2. The fame thing is likewife obferved of the phenomena of Saturn. 3. The five primary planets, Mercury, Venus, Mars, Jupiter, and Saturn, with their feveral orbits, encompafs the fun. 4. The fixed ftars being fuppofed at reft, the periodic times of the five primary planets, and of the earth, about the fun, are in the fefquiplicate proportion of their mean diftances from the fun. 5. The primary planets, by radii drawn to the earth, defcribe areas no ways proportionable to the times: but the areas which they defcribe by radii drawn to the fun are proportional to the times of defcription. 6. The moon, by a radius drawn to the centre of the earth, defcribes an area proportional to the time of defcription. All thefe phenomena are undeniable from aftronomical obfervations, and are explained at large under the article Astronomy. The mathematical demonftrations are next applied by Sir Ifaac Newton in the following propofitions.

Prop. I. The forces by which the Satellites of Jupiter are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the centre of that planet; and are reciprocally as the fquares of the diftances of thofe fatellites from that centre. The former part of this propofition appears from theor. 2. or 3. and the latter from cor. 6. of theor. 5.; and the fame thing we are to underftand of the fatellites of Saturn.

Prop. II. The forces by which the primary planets are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the fun; and are reciprocally as the fquares of the diftances from the fun's centre. The former part of this propofition is manifeft from phænomenon 5. juft mentioned, and from theor. 2.; the latter from phænom. 4. and cor. 6. of theor. 4. But this part of the propofition is with great accuracy deducible from the quiefcence of the aphelion points. For a very fmall aberration from the reciprocal duplicate proportion would produce a motion of the apfides, fenfible in every fingle revolution, and in many of them enormoufly great.

Prop. III. The force by which the moon is retained in its orbit, tends towards the earth; and is reciprocally as the fquare of the diftance of its place from the centre of the earth. The former part of this propofition is evident from phænom. 5. and theor. 2.; the latter from phænom. 6. and theor. 2. or 3. It is alfo evident from the very flow motion of the moon's apogee; which, in every fingle revolution, amounting but to 3° 3′ *in confequentia*, may be neglected: and this more fully appears from the next propofition.

Prop. IV. The moon gravitates towards the earth, and by the force of gravity is continually drawn off from a rectilinear motion, and retained in its orbit.—The mean diftance of the moon from the earth in the fyzigies in femidiameters of the latter, is about $60\frac{1}{2}$. Let us affume the mean diftance of 60 femidiameters in the fyzigies; and fuppofe one revolution of the moon in refpect of the fixed ftars to be completed in $27^{d}.\ 7^{h}.\ 43'$, as aftronomers have determined; and the circumference of the earth to amount to 123,249,600 Paris feet. Now, if we imagine the moon, deprived of all motion, to be let go, fo as to defcend towards the earth with the impulfe of all that force by which it is retained in its orbit, it will, in the fpace of one minute of time, defcribe in its fall $15\frac{1}{4}$ Paris feet. For the verfed fine of that arc which the moon, in the fpace of one minute of time, defcribes by its mean motion at the diftance of 60 femidiameters of the earth, is nearly $15\frac{1}{12}$ Paris feet; or more accurately, 15 feet 1 inch and 1 line $\frac{4}{9}$. Wherefore fince that force, in approaching to the earth, increafes in the reciprocal duplicate proportion of the diftance; and, upon that account, at the furface of the earth is 60×60 times greater than at the moon; a body in our regions, falling with that force, ought, in the fpace of one minute of time, to defcribe $60\times60\times15\frac{1}{12}$ Paris feet; and in the fpace of one fecond of time to defcribe $15\frac{1}{12}$ of thofe feet; or, more accurately, 15 feet 1 inch, 1 line $\frac{4}{9}$. And with this very force we actually find that bodies here on earth do really defcend. For a pendulum ofcillating feconds in the latitude of Paris, will be three Paris feet and $8\frac{1}{2}$ lines in length, as Mr Huygens has obferved. And the fpace which a heavy body defcribes by falling one fecond of time, is to half the length of the pendulum in the duplicate ratio of the circumference of the circle to its diameter; and is therefore 15 Paris feet, 1 inch, 1 line $\frac{7}{9}$. And therefore the force by which the moon is retained in its orbit, becomes, at the very furface of the earth, equal to the force of gravity which we obferve in heavy bodies there. And therefore (by rule 1. and 2.) the force by which the moon is retained in its orbit is that very fame force which we commonly call *gravity*. For were gravity another force different from that, then bodies defcending to the earth with the joint impulfe of both forces, would fall with a double velocity, and, in the fpace of one fecond of time, would defcribe $30\frac{1}{6}$ Paris feet; altogether againft experience.

The demonftration of this propofition may be more diffufely explained after the following manner. Suppofe feveral moons to revolve about the earth, as in the fyftem of Jupiter or Saturn, the periodic times of thofe moons would (by the argument of induction) obferve the fame law which Kepler found to obtain among the planets; and therefore their centripetal forces would be reciprocally as the fquares of the diftances from the centre of the earth by Prop. I. Now, if the

Newtonian Philoſophy

the loweſt of theſe were very ſmall, and were ſo near the earth as almoſt to touch the tops of the higheſt mountains, the centripetal force thereof, retaining it in its orbit, would be very nearly equal to the weights of any terreſtrial bodies that ſhould be found upon the tops of theſe mountains; as may be known from the foregoing calculation. Therefore if the ſame little moon ſhould be deſerted by its centrifugal force that carries it through its orb, it would deſcend to the earth; and that with the ſame velocity as heavy bodies do actually deſcend with upon the tops of thoſe very mountains, becauſe of the equality of forces that oblige them both to deſcend. And if the force by which that loweſt moon would deſcend were different from that of gravity, and if that moon were to gravitate towards the earth, as we find terreſtrial bodies do on the tops of mountains, it would then deſcend with twice the velocity, as being impelled by both theſe forces conſpiring together. Therefore, ſince both theſe forces, that is, the gravity of heavy bodies, and the centripetal forces of the moons, reſpect the centre of the earth, and are ſimilar and equal between themſelves, they will (by rule 1. and 2.) have the ſame cauſe. And therefore the force which retains the moon in its orbit, is that very force which we commonly call *gravity;* becauſe otherwiſe this little moon at the top of a mountain muſt either be without gravity, or fall twice as ſwiftly as heavy bodies uſe to do.

Having thus demonſtrated that the moon is retained in its orbit by its gravitation towards the earth, it is eaſy to apply the ſame demonſtration to the motions of the other ſecondary planets, and of the primary planets round the ſun, and thus to ſhew that gravitation prevails throughout the whole creation; after which, Sir Iſaae proceeds to ſhew from the ſame principles, that the heavenly bodies gravitate towards each other, and contain different quantities of matter, or have different denſities in proportion to their bulks.

Prop. V. All bodies gravitate towards every planet; and the weights of bodies towards the ſame planet at equal diſtances from its centre, are proportional to the quantities of matter they contain.

It has been confirmed by many experiments, that all ſorts of heavy bodies (allowance being made for the inequality of retardation by ſome ſmall reſiſtance of the air) deſcend to the earth from equal heights in equal times; and that equality of times we may diſtinguiſh to a great accuracy, by the help of pendulums. Sir Iſaac Newton tried the thing in gold, ſilver, lead, glaſs, ſand, common ſalt, wood, water, and wheat. He provided two wooden boxes, round and equal, filled the one with wood, and ſuſpended an equal weight of gold in the centre of oſcillation of the other. The boxes hanging by equal threads of 11 feet, made a couple of pendulums, perfectly equal in weight and figure, and equally receiving the reſiſtance of the air. And placing the one by the other, he obſerved them to play together forwards and backwards, for a long time, with equal vibrations. And therefore the quantity of matter in the gold was to the quantity of matter in the wood, as the action of the motive force (or *vis motrix*) upon all the gold, to the action of the ſame upon all the wood; that is, as the weight of the one to the weight of the other. And the like happened in the other bodies. By theſe experiments, in bodies of the ſame weight, he could manifeſtly have diſcovered a difference of matter leſs than the thouſandth part of the whole, had any ſuch been. But, without all doubt, the nature of gravity towards the planets, is the ſame as towards the earth. For, ſhould we imagine our terreſtrial bodies removed to the orb of the moon, and there, together with the moon, deprived of all motion, to be let go, ſo as to fall together towards the earth; it is certain, from what we have demonſtrated before, that, in equal times, they would deſcribe equal ſpaces with the moon, and of conſequence are to the moon, in quantity of matter, as their weights to its weight. Moreover, ſince the ſatellites of Jupiter perform their revolutions in times which obſerve the ſeſquiplicate proportion of their diſtances from Jupiter's centre, their accelerative gravities towards Jupiter will be reciprocally as the ſquares of their diſtances from Jupiter's centre; that is, equal at equal diſtances. And therefore, theſe ſatellites, if ſuppoſed to fall towards Jupiter from equal heights, would deſcribe equal ſpaces in equal times, in like manner as heavy bodies do on our earth. And by the ſame argument, if the circumſolar planets were ſuppoſed to be let fall at equal diſtances from the ſun, they would, in their deſcent towards the ſun, deſcribe equal ſpaces in equal times. But forces, which equally accelerate unequal bodies, muſt be as thoſe bodies; that is to ſay, the weights of the planets towards the ſun muſt be as their quantities of matter. Further, that the weights of Jupiter and of his ſatellites towards the ſun are proportional to the ſeveral quantities of their matter, appears from the exceeding regular motions of the ſatellites. For if ſome of thoſe bodies were more ſtrongly attracted to the ſun in proportion to their quantity of matter than others, the motions of the ſatellites would be diſturbed by that inequality of attraction. If, at equal diſtances from the ſun, any ſatellite, in proportion to the quantity of its matter, did gravitate towards the ſun, with a force greater than Jupiter in proportion to his, according to any given proportion, ſuppoſe of *d* to *e;* then the diſtance between the centres of the ſun and of the ſatellite's orbit would be always greater than the diſtance between the centres of the ſun and of Jupiter, nearly in the ſubduplicate of that proportion. And if the ſatellite gravitated towards the ſun with a force, leſſer in the proportion of *e* to *d*, the diſtance of the centre of the ſatellite's orb from the ſun, would be leſs than the diſtance of the centre of Jupiter's from the ſun, in the ſubduplicate of the ſame proportion. Therefore, if, at equal diſtances from the ſun, the accelerative gravity of any ſatellite towards the ſun, were greater or leſs than the accelerating gravity of Jupiter towards the ſun, but by one $\frac{1}{1000}$ part of the whole gravity; the diſtance of the centre of the ſatellite's orbit from the ſun would be greater or leſs than the diſtance of Jupiter from the ſun, by one $\frac{1}{2000}$ part of the whole diſtance; that is, by a fifth part of the diſtance of the utmoſt ſatellite from the centre of Jupiter; an excentricity of the orbit, which would be very ſenſible. But the orbits of the ſatellites are concentric to Jupiter; therefore the accelerative gravities of Jupiter, and of all its ſatellites, towards the ſun, are equal among themſelves. And by the ſame argument, the weight of Saturn and of his ſatellites towards the ſun, at equal diſtances from the ſun, are as their ſeveral quantities of

of matter; and the weights of the moon and of the earth towards the fun, are either none, or accurately proportional to the maffes of matter which they contain.

But further, the weights of all the parts of every planet towards any other planet, are one to another as the matter in the feveral parts. For if fome parts gravitated more, others lefs, than for the quantity of their matter; then the whole planet, according to the fort of parts with which it moft abounds, would gravitate more or lefs, than in proportion to the quantity of matter in the whole. Nor is it of any moment whether thefe parts are external or internal. For if, for example, we fhould imagine the terreftrial bodies with us to be raifed up to the orb of the moon, to be there compared with its body; if the weights of fuch bodies were to the weights of the external parts of the moon, as the quantities of matter in the one and in the other refpectively; but to the weights of the internal parts, in a greater or lefs proportion; then likewife the weights of thofe bodies would be to the weight of the whole moon, in a greater or lefs proportion; againft what we have fhewed above.

Cor. 1. Hence the weights of bodies do not depend upon their forms and textures. For if the weights could be altered with the forms, they would be greater or lefs, according to the variety of forms in equal matter; altogether againft experience.

Cor. 2. Univerfally, all bodies about the earth gravitate towards the earth; and the weights of all, at equal diftances from the earth's centre, are as the quantities of matter which they feverally contain. This is the quality of all bodies within the reach of our experiments; and therefore (by rule 3.) to be affirmed of all bodies whatfoever. If the ether, or any other body, were either altogether void of gravity, or were to gravitate lefs in proportion to its quantity of matter; then, becaufe (according to Ariftotle, Des Cartes, and others) there is no difference betwixt that and other bodies, but in mere form of matter, by a fucceffive change from form to form, it might be changed at laft into a body of the fame condition with thofe which gravitate moft in proportion to their quantity of matter; and, on the other hand, the heavieft bodies, acquiring the firft form of that body, might by degrees quite lofe their gravity. And therefore the weights would depend upon the forms of bodies, and with thofe forms might be changed, contrary to what was proved in the preceding corollary.

Cor. 3. All fpaces are not equally full. For if all fpaces were equally full, then the fpecific gravity of the fluid which fills the region of the air, on account of the extreme denfity of the matter, would fall nothing fhort of the fpecific gravity of quick-filver, or gold, or any other the moft denfe body; and therefore, neither gold, nor any other body, could defcend in air. For bodies do not defcend in fluids, unlefs they are fpecifically heavier than the fluids. And if the quantity of matter in a given fpace can by any rarefaction be diminifhed, what fhould hinder a diminution to infinity?

Cor. 4. If all the folid particles of all bodies are of the fame denfity, nor can be rarefied without pores, a void fpace or vacuum muft be granted. [By bodies of the fame denfity, our author means thofe whofe *vires inertiæ* are in the proportion of their bulks.]

Prop. VI. That there is a power of gravity tending to all bodies, proportional to the feveral quantities of matter which they contain.

That all the planets mutually gravitate one towards another, we have proved before; as well as that the force of gravity towards every one of them, confidered apart, is reciprocally as the fquare of the diftance of places from the centre of the planet. And thence it follows, that the gravity tending towards all the planets, is proportional to the matter which they contain.

Moreover, fince all the parts of any planet *A* gravitate towards any other planet *B*; and the gravity of every part is to the gravity of the whole, as the matter of the part to the matter of the whole; and (by law 3.) to every action correfponds an equal re-action: therefore the planet *B* will, on the other hand, gravitate towards all the parts of the planet *A*; and its gravity towards any one part will be to the gravity towards the whole, as the matter of the part to the matter of the whole. *Q. E. D.*

Cor. 1. Therefore the force of gravity towards any whole planet, arifes from, and is compounded of, the forces of gravity towards all its parts. Magnetic and electric attractions afford us examples of this. For all attraction towards the whole arifes from the attractions towards the feveral parts. The thing may be eafily underftood in gravity, if we confider a greater planet as formed of a number of leffer planets, meeting together in one globe. For hence it would appear that the force of the whole muft arife from the forces of the component parts. If it be objected, That, according to this law, all bodies with us muft mutually gravitate one towards another, whereas no fuch gravitation any where appears; it is anfwered, That fince the gravitation towards thefe bodies is to the gravitation towards the whole earth, as thefe bodies are to the whole earth, the gravitation towards them muft be far lefs than to fall under the obfervation of our fenfes. [The experiments with regard to the attraction of mountains, however, have now further elucidated this point.]

Cor. 2. The force of gravity towards the feveral equal particles of any body, is reciprocally as the fquare of the diftance of places from the particles.

Prop. VII. In two fpheres mutually gravitating each towards the other, if the matter, in places on all fides round about and equidiftant from the centres, is fimilar; the weight of either fphere towards the other, will be reciprocally as the fquare of the diftance between their centres.

For the demonftration of this, fee the *Principia*, book i. prop. 75 and 76.

Cor. 1. Hence we may find and compare together the weights of bodies towards different planets. For the weights of bodies revolving in circles about planets, are as the diameters of the circles directly, and the fquares of their periodic times reciprocally; and their weights at the furfaces of the planets, or at any other diftances from their centres, are (by this prop.) greater or lefs, in the reciprocal duplicate proportion of the diftances. Thus from the periodic times of Venus, revolving about the fun, in $224^{d}.\ 16\frac{3}{4}^{h}$; of the utmoft circumjovial fatellite revolving about Jupiter, in $16^{d}.\ 16\frac{8}{15}^{h}$; of the Huygenian fatellite about Saturn in $15^{d}.\ 22\frac{2}{3}^{h}$; and of the moon about the earth in $27^{d}.\ 7^{h}$.

Newtonian Philosophy

$7^h. 43'$; compared with the mean diftance of Venus from the fun, and with the greateft heliocentric elongations of the outmoft circumjovial fatellite from Jupiter's centre, $8' 16''$; of the Huygenian fatellite from the centre of Saturn, $3' 4''$; and of the moon from the earth, $10' 33''$; by computation our author found, that the weight of equal bodies, at equal diftances from the centres of the fun, of Jupiter, of Saturn, and of the earth, towards the fun, Jupiter, Saturn, and the earth, were one to another, as $\frac{1}{1067}$, $\frac{1}{3021}$, and $\frac{1}{169282}$ refpectively. Then, becaufe, as the diftances are increafed or diminifhed, the weights are diminifhed or increafed in a duplicate ratio; the weights of equal bodies towards the fun, Jupiter, Saturn, and the earth, at the diftances 10000, 997, 791, and 109, from their centres, that is, at their very fuperficies, will be as 10000, 943, 529, and 435 refpectively.

Cor. 2. Hence likewife we difcover the quantity of matter in the feveral planets. For their quantities of matter are as the forces of gravity at equal diftances from their centres, that is, in the fun, Jupiter, Saturn, and the earth, as 1, $\frac{1}{1067}$, $\frac{1}{3021}$, and $\frac{1}{169282}$ refpectively. If the parallax of the fun be taken greater or lefs than $10'' 30'''$, the quantity of matter in the earth muft be augmented or diminifhed in the triplicate of that proportion.

Cor. III. Hence alfo we find the denfities of the planets. For (by prop. 72. book 1.) the weights of equal and fimilar bodies towards fimilar fpheres, are, at the furfaces of thofe fpheres, as the diameters of the fpheres. And therefore the denfities of diffimilar fpheres are as thofe weights applied to the diameters of the fpheres. But the true diameters of the fun, Jupiter, Saturn, and the earth, were one to another as 10000, 997, 791, and 109; and the weights towards the fame, as 10000, 943, 529, and 435 refpectively; and therefore their denfities are as 100, $94\frac{1}{2}$, 67, and 400. The denfity of the earth, which comes out by this computation, does not depend upon the parallax of the fun, but is determined by the parallax of the moon, and therefore is here truly defined. The fun therefore is a little denfer than Jupiter, and Jupiter than Saturn, and the earth four times denfer than the fun; for the fun, by its great heat, is kept in a fort of a rarefied ftate. The moon is denfer than the earth.

Cor. 4. The fmaller the planets are, they are, *cæteris paribus*, of fo much the greater denfity. For fo the powers of gravity on their feveral furfaces come nearer to equality. They are likewife, *cæteris paribus*, of the greater denfity as they are nearer to the fun. So Jupiter is more denfe than Saturn, and the earth than Jupiter. For the planets were to be placed at different diftances from the fun, that, according to their degrees of denfity, they might enjoy a greater or lefs proportion of the fun's heat. Our water, if it were removed as far as the orb of Saturn, would be converted into ice, and in the orb of Mercury would quickly fly away in vapour. For the light of the fun, to which its heat is proportional, is feven times denfer in the orb of Mercury than with us: and by the thermometer Sir Ifaac found, that a fevenfold heat of our fummer-fun will make water boil. Nor are we to doubt, that the matter of Mercury is adapted to its heat, and is therefore more denfe than the matter of our earth; fince, in a denfer matter, the operations of nature require a ftronger heat.

It is fhewn in the fcholium of prop. 22. book 2. of the *Principia*, that at the height of 200 miles above the earth, the air is more rare than it is at the fuperficies of the earth, in the ratio of 30 to 0,0000000000003998, or as 75000000000000 to 1 nearly. And hence the planet Jupiter, revolving in a medium of the fame denfity with that fuperior air, would not lofe by the refiftance of the medium the 1000000th part of its motion in 1000000 years. In the fpaces near the earth, the refiftance is produced only by the air, exhalations, and vapours. When thefe are carefully exhaufted by the air-pump from under the receiver, heavy bodies fall within the receiver with perfect freedom, and without the leaft fenfible refiftance; gold itfelf, and the lighteft down, let fall together, will defcend with equal velocity; and though they fall through a fpace of four, fix, and eight feet, they will come to the bottom at the fame time; as appears from experiments. And therefore the celeftial regions being perfectly void of air and exhalations, the planets and comets meeting no fenfible refiftance in thofe fpaces, will continue their motions through them for an immenfe fpace of time.

Niagara.

NIAGARA, a fort of North America taken from the French during the laft war, which in a manner commands all the interior parts of the continent, and is a key to the whole of North America. It is fituated on the lake Ontario; and about fix leagues from it is the greateft cataract in the world, known by the name of the *water-fall of Niagara*. The river at this fall runs from S. S. E. to N. N. W. and the rock of the fall croffes it not in a right line, but forming a kind of figure like an hollow femicircle or horfefhoe. Above the fall, in the middle of the river, is an ifland about 800 or 1000 feet long; the lower end of which is juft at the perpendicular edge of the fall. On both fides of this ifland runs all the water that comes from the lakes of Canada; viz. Lake Superior, Lake Mifchigan, Lake Huron, and Lake Eric, which have fome large rivers that open themfelves into them. Before the water comes to this ifland, it runs but flowly compared with its motion afterwards, when it grows the moft rapid in the world, running with a furprifing fwiftnefs before it comes to the fall. It is perfectly white, and in many places is thrown high up into the air. The water that runs down on the weft fide is more rapid, in greater abundance, and whiter, than that on the eaft fide; and feems almoft to outfly an arrow in fwiftnefs. When you are at the fall, and look up the river, you may fee that the water is every where exceedingly fteep, almoft like the fide of an hill; but when you come to look at the fall itfelf, it is impoffible to exprefs the amazement it occafions. The height of it, as meafured by mathematical inftruments, is found to be exactly 137 feet; and when the water is come to the bottom, it jumps back to a very great height in the air. The noife may be heard at the diftance of 45 miles, but feldom further; nor can it be heard even at Fort Niagara, which is only fix leagues diftant, unlefs Lake Ontario is calm. At that fort it is obferved, that when they hear the noife of the fall more loud than ordinary, they are fure that a north-eaft wind will follow; which is the more fur-

Niagara. prifing, as the fort lies fouth-weft from the fall. At fome times the fall makes a much greater noife than at others; and this is held for an infallible fign of approaching rain or other bad weather.

From the place where the water falls there arifes abundance of vapour like very thick fmoke, infomuch that when viewed at a diftance you would think that the Indians had fet the forefts on fire. Thefe vapours rife high in the air when it is calm, but are difperfed by the wind when it blows hard. If you go into this vapour or fog, or if the wind blows it on you, it is fo penetrating, that a few moments you will be as wet as if you had been nnder water. Some are of opinion, that when birds come flying into this fog or fmoke of the fall, they drop down and perifh in the water; either becaufe their wings are become wet, or that the noife of the fall aftonifhes them, and they know not where to go in the darknefs: but others think that feldom or never any bird perifhes there in that manner; becaufe, among the abundance of birds found dead below the fall, there are no other forts than fuch as live and fwim frequently in the water; as fwans, geefe, ducks, water-hens, teal, and the like. And very often great flocks of them are feen going to deftruction in this manner: they fwim in the river above the fall, and fo are carried down lower and lower by the water; and as water-fowl commonly take great delight in being carried with the ftream, they indulge themfelves in enjoying this pleafure fo long, till the fwiftnefs of the water becomes fo great, that it is no longer poffible for them to rife, but they are driven down the precipice, and perifh. They are obferved, when they draw nigh the fall, to endeavour with all their might to take wing and leave the water; but they cannot. In the months of September and October fuch abundant quantities of dead water-fowl are found every morning below the fall, on the fhore, that the garrifon of the fort for a long time live chiefly upon them. Befides the fowl, they find alfo feveral forts of dead fifh, alfo deer, bears, and other animals which have tried to crofs the water above the fall; the larger animals are generally found broken to pieces. Juft below, a little way from the fall, the water is not rapid, but goes all in circles, and whirls like a boiling pot; which however does not hinder the Indians going upon it in fmall canoes a-fifhing; but a little further, and lower, the other fmaller falls begin. When you are above the fall, and look down, your head begins to turn; even fnch as have been here numberlefs times, will feldom venture to look down, without at the fame time keeping faft hold of fome tree with one hand.

It was formerly thought impoffible for any body living to come at the ifland that is in the middle of the fall: but an accident that happened 34 years ago, or thereabouts, made it appear otherwife. The hiftory is this: Two Indians of the Six Nations went out from Niagara fort to hunt upon an ifland that is in the middle of the river, or ftrait, above the great fall, on which there ufed to be abundance of deer. They took fome French brandy with them from the fort, which they tafted feveral times as they were going over the carrying-place; and when they were in their canoe, they took now and then a dram, and fo went along up the ftrait towards the ifland where they propofed to hunt; but growing fleepy, they laid themfelves down in the canoe, which getting loofe drove back with the ftream, farther and farther down, till it came nigh that ifland that is in the middle of the fall. Here one of them, awakened by the noife of the fall, cries out to the other, that they were gone: Yet they tried if poffible to fave life. This ifland was nigheft, and with much working they got on fhore their. At firft they were glad; but when they had confidered every thing, they thought themfelves hardly in a better ftate than if they had gone down the fall, fince they had now no other choice, than either to throw themfelves down the fame, or perifh with hunger. But hard neceffity put them on invention. At the lower end of the ifland the rock is perpendicular, and no water is running there. The ifland has plenty of wood; they went to work then, and made a ladder or fhrouds of the bark of the lind-tree (which is very tough and ftrong) fo long till they could with it reach the water below; onc end of this bark-ladder they tied faft to a great tree that grew at the fide of the rock above the fall, and let the other end down to the water. So they went down along their new-invented ftairs, and when they came to the bottom in the middle of the fall they refted a little; and as the water next below the fall is not rapid, as before-mentioned, they threw themfelves out into it, thinking to fwim on fhore. We have faid before, that one part of the fall is on one fide of the ifland, the other on the other fide. Hence it is, that the waters of the two cataracts running againft each other, turn back againft the rock that is juft under the ifland. Therefore, hardly had the Indians begun to fwim, before the waves of the eddy threw them down with violence againft the rock from whence they came. They tired it feveral times, but at laft grew weary; and by being often thrown againft the rock they were much bruifed, and the fkin torn off their bodies in many places. So they were obliged to climb up ftairs again to the ifland, not knowing what to do. After fome time they perceived Indians on the fhore, to whom they cried out. Thefe faw and pitied them, but gave them little hope or help: yet they made hafte down to the fort, and told the commandant where two of their brothers were. He perfuaded them to try all poffible means of relieving the two poor Indians; and it was done in the following manner.

The water that runs on the eaft fide of this ifland is fhallow, efpecially a little above the ifland towards the eaftern fhore. The commandant caufed poles to be made and pointed with iron; two Indians took upon them to walk to this ifland by the help of thefe poles, to fave the other poor creatures, or perifh themfelves. They took leave of all their friends, as if they were going to death. Each had two fuch poles in his hands, to fet to the bottom of the ftream, to keep them fteady. So they went and got to the ifland, and having given poles to the two poor Indians there, they all returned fafely to the main. Thefe two Indians who in the abovementioned manner were firft brought to this ifland were nine days on the ifland, and almoft ready to ftarve to death. Now fince the road to this ifland has been found, the Indians go there often to kill deer, which have tried to crofs the river above the fall, and are driven upon the ifland by the ftream. On the

the weſt ſide of this iſland are ſome ſmall iſlands or rocks, of no conſequence. The eaſt ſide of the river is almoſt perpendicular, the weſt ſide more ſloping. In former times a part of the rock at the fall which is on the weſt ſide of the iſland, hung over in ſuch a manner, that the water which fell perpendicularly from it, left a vacancy below, ſo that people could go under between the rock and the water; but the prominent part ſome years ſince broke off and fell down. The breadth of the fall, as it runs in a ſemi-circle, is reckoned to be about 300 feet. The iſland is in the middle of the fall, and from it on each ſide is almoſt the ſame breadth; the breadth of the iſland at its lower end is about 100 feet. Below the fall, in the holes of the rocks, are great plenty of eels, which the Indians and French catch with their hands without any other means. Every day when the ſun ſhines, you ſee here from ten o'clock in the morning to two in the afternoon, below the fall, and under you, where you ſtand at the ſide of the fall, a glorious rainbow, and ſometimes two, one within the other. The more vapours, the brighter and clearer is the rainbow. When the wind carries the vapours from that place, the rainbow is gone, but appears again as ſoon as new vapours come. From the fall to the landing above it, where the canoes from Lake Erie put aſhore (or from the fall to the upper end of the carrying-place) is half a mile. Lower the canoes dare not come, leſt they ſhould be obliged to try the fate of the two Indians, and perhaps with leſs ſucceſs. They have often found below the fall pieces of human bodies, perhaps drunken Indians, that have unhappily come down to the fall. The French ſay, that they have often thrown whole great trees into the water above, to ſee them tumble down the fall: they went down with ſurpriſing ſwiftneſs, but could never be ſeen afterwards; whence it was thought there was a bottomleſs deep or abyſs juſt under the fall. The rock of the fall conſiſts of a grey limeſtone.

NICÆA, (anc. geogr.), the metropolis of Bithynia; ſituate on the lake Aſcanius, in a large and fertile plain; in compaſs 16 ſtadia: firſt built by Antigonus, the ſon of Philip, and thence called *Antigonea;* afterwards completed by Lyſimachus, who called it *Nicæa*, after his conſort the daughter of Antipater. According to Stephanus, it was originally a colony of the Bottiæi, a people of Thrace, and called *Ancore;* and afterwards called *Nicæa*. Now *Nice* in Aſia the Leſs. Famous for the firſt general council.—A ſecond *Nicæa*, (Diodorus Siculus,) of Corſica.—A third, of the Hither India, (Arrian); ſituate on the weſt ſide of the Hydaſpes, oppoſite to Buciphale, on the eaſt ſide.—A fourth *Nicæa*, a town of Liguria, at the Maritime Alps, on the eaſt ſide of the river Paulon near its mouth, which runs between the Varus and Nicæa, (Mela). A colony of the Maſſilians, (Stephanus); the laſt town of Italy to the weſt. Now *Nizza* or *Nice*, capital of the county of that name, on the Mediterranean.—A fifth, of Locris, (Strabo); a town near Thermopylæ; one of the keys of that paſs. It ſtood on the Sinus Maliacus.

NICANDER *of* COLOPHON, a celebrated grammarian, poet, and phyſician, who lived about the 160th Olympiad, 140 years before Chriſt, in the reign of Attalus king of Pergamus, who overcame the Gallo-Greeks. He lived many years in Etolia, of which country he wrote a hiſtory. He wrote alſo many other works, of which only two are now remaining. The one is intitled *Theriaca*, deſcribing in verſe the accidents attending wounds made by venomous beaſts, with the proper remedies; the other bearing the title of *Alexipharmaca*, wherein he treats poetically of poiſons and their antidotes. This Nicander is not to be confounded with Nicander of Thyatira.

NICARAGUA, a large river of South America, in a province of the ſame name, whoſe weſtern extremity lies within 5 miles of the South Sea. It is full of dreadful cataracts, and falls at length into the North Sea.

NICARAGUA, a maritime province of South America, in Mexico, bounded on the north by Honduras, on the eaſt by the North Sea, on the ſouth-eaſt by Coſta Rica, and on the ſouth-weſt by the South Sea; being 400 miles in length from eaſt to weſt, and 120 in breadth from north to ſouth. It is one of the moſt fruitful and agreeable provinces in Mexico, and is well watered with lakes and rivers. The air is wholeſome and temperate; and this country produces plenty of ſugar, cochineal, and fine chocolate. One of the lakes is 200 miles in circumference, has an iſland in the middle, and, as ſome ſay, has a tide. Leon de Nicaragua is the capital town.

NICARIA, an iſland of the Archipelago, between Samos and Tine, about 50 miles in circumference. A chain of high mountains run thro' the middle, covered with wood, and ſupply the country with ſprings. The inhabitants are very poor, and of the Greek communion; however, they have a little wheat, and a good deal of barley, figs, honey, and wax.

NICASTRO, an epiſcopal town of Italy, in the kingdom of Naples, and in the Farther Calabria; 16 miles ſouth of Coſenza. E. Long. 15. 59. N. Lat. 39. 15.

NICE, an ancient, handſome, and conſiderable town on the confines of France and Italy, and capital of a county of the ſame name, with a ſtrong citadel, a biſhop's ſee, and a ſenate, which is a kind of a democracy. It has been ſeveral times taken by the French, and laſt of all in 1744, but rendered back after the treaty of Aix-la-Chapelle. It is very agreeably ſituated, four miles from the mouth of the river Var, 83 miles S. by W. of Turin, and 83 eaſt of Aix. E. Long. 6. 22. N. Lat. 43. 42.

NICE, a county and province in the dominions of the duke of Savoy, bounded on the eaſt by the territory of Genoa and Proper Piedmont, on the north by the marquiſate of Saluces and Dauphiny, on the weſt by Provence and the Mediterranean ſea, and on the ſouth by the principality of Monaco. The inhabitants ſupply Genoa with a great deal of timber for building ſhips; and carry on a great trade in linen-cloth, paper, oil, wine, and honey. Nice is the capital town.

NICE, an ancient town of Aſia, in Natolia, now called *Iſnick*, with a Greek archbiſhop's ſee. It is famous for the general council aſſembled here in 325, who endeavoured to ſuppreſs the doctrines of Arius. It was formerly a large, populous, and well-built place, and now is not inconſiderable. See ISNIC.

NICEPHORUS (Gregorius), a Greek hiftorian in the 14th century, was librarian to the church of Conftantinople, and had a great fhare in the tranfactions of his time. He wrote a hiftory, which extends from the year 1204 to 1341. The beft edition of this work is that of the Louvre, in Greek and Latin, in 1702.

NICEPHORUS (Califtus), a Greek hiftorian, who flourifhed in the 14th century under the emperor Andronicus Paleologus the elder, wrote an ecclefiaftical hiftory in 23 books; 18 of which are ftill extant, containing the tranfactions of the church from the birth of Chrift to the death of the emperor Phocas in 610. We have nothing elfe but the arguments of the other five books from the commencement of the reign of the emperor Heraclius to the end of that of Leo the philofopher, who died in the year 911. Nicephorus dedicated his hiftory to Andronicus Paleologus the Elder. It was tranflated into Latin by John Langius; and has gone through feveral editions, the beft of which is that of Paris in 1630.

NICERON (John Francis), an ingenious minim, born at Paris in 1613, who diftinguifhed himfelf by his knowledge in Optics, concerning which he wrote fome treatifes, though he died at the age of 33.

NICERON (John Peter), was born at Paris, of an ancient and noble family, in the year 1685. He entered young into the order of Barnabites, and was profeffor of rhetoric and philofophy in the college of Montargis. He is fufficiently known for conducting the "Memoirs of men illuftrious in the republic of letters," of which he publifhed 39 volumes. He alfo tranflated fome Englifh works into French.

NICETAS (David), a Greek hiftorian, a native, as fome relate, of Paphlagonia, who lived about the end of the 9th century. He wrote, The life of St Ignatius, patriarch of Conftantinople; which was tranflated into Latin by Frederic Mutius bifhop of Termoli: he compofed alfo feveral panegyrics in honour of the apoftles and other faints, which are inferted in the laft continuation of the *Bibliotheca Patrum* by Combefis.

NICETAS (furnamed SERRON), deacon of the church of Conftantinople, cotemporary with Theophylact in the 11th century, and afterwards bifhop of Heraclea, wrote a Catena upon the book of Job, compiled from paffages of feveral of the fathers, which was printed at London in folio, 1637. We have alfo, by the fame writer, feveral *catenæ* upon the Pfalms and Canticles, Bafil 1552; together with a Commentary on the poems of Gregory Nazianzen.

NICETAS (Arhominatis), a Greek hiftorian of the 13th century, called *Coniates*, as being born at Chone, or Coloffus, in Phrygia. He was employed in feveral confiderable affars at the court of Conftant'nople; and when that city was taken by the French in 1204, he withdrew with a young girl taken from the enemy, to Nice in Bithynia, where he married his captive, and died in 1206. He wrote a Hiftory, or Annals, from the death of Alexius Comnenus in the year 1118, to that of Badouin in 1205: of which work we have a Latin tranflation by Jerome Wolfius, printed at Bafil in 1557; and it has been inferted in the body of the Byzantine Hiftorians, printed in France at the Louvre.

NICHE, in architecture, a hollow funk into a wall, for the commodious and agreeable placing of a ftatue. The word comes from the Italian *nechia*, "fea-fhell;" in regard the ftatue is here inclofed in a fhell, or perhaps on account of the fhell wherewith the tops of fome of them are adorned.

NICIAS, a celebrated painter of Athens, flourifhed about 322 years before the Chriftian æra; and was univerfally extolled for the great variety and noble choice of his fubjects, the force and relievo of his figures, his fkill in the diftribution of the lights and fhadows, and his dexterity in reprefenting all forts of four-footed animals, beyond any mafter of his time. His moft celebrated piece was that of Tartarus or Hell, as it is defcribed by Homer, for which king Ptolemy the fon of Lagus offered him 60 talents, or 11,250l. which he refufed, and generoufly prefented it to his own country. He was likewife much efteemed by all his cotemporaries, for his excellent talent in fculpture.

NICKEL, a femi-metal, firft defcribed by Mr Cronftedt in the Swedifh Memoirs for the years 1751 and 1754. The properties there attributed to it are, 1. That it is of a white colour, inclining to red. 2. Its texture is folid, and fhining in its fractures. 3. Its fpecific gravity is to that of water as 8500 to 1000. 4. It is confiderably fixed in the fire. 5. It is calcinable, and its calx is green. 6. This calx is not very fufible; but it neverthelefs tinges glafs of a tranfparent reddifh brown, or jacinth colour. 7. It diffolves in aquafortis, aqua regia, and marine acid, but difficultly in vitriolic acid. All thefe folutions have a deep-green colour. The vitriol formed of it is alfo of the fame colour; and the colcothar of this vitriol, and alfo the precipitates from the folutions, are rendered by calcination of a light-green colour. 8. Thefe precipitates are foluble by fpirit of fal ammoniac, and the folution has a blue colour. But no copper can be produced by a reduction of the precipitates. 9. It ftrongly attracts fulphur. 10. It unites with all metallic fubftances, excepting filver, quickfilver, and zinc. Its attraction to regulus of cobalt is the ftrongeft, next to which is that to iron, and then to arfenic. 11. It retains its phlogifton a long time in the fire, and its calx is reducible by a very fmall quantity of inflammable matter. It requires, however, a ftrong red heat before it can be fufed, and melts a little fooner, or as foon as gold or copper. Nickel is contained in the reddifh-yellow mineral, called *Kupfer-nickel*, which, befides nickel, contains alfo iron, regulus of cobalt, arfenic, and fulphur.

NICOBAR ISLANDS, the name of feveral iflands in Afia, lying at the entrance of the gulph of Bengal. The largeft of thefe iflands is about 40 miles long and 15 broad, and the inhabitants are faid to be a harmlefs fort of people, ready to fupply the fhips that ftop there with provifions.

NICOLAITANS, in church-hiftory, Chriftian heretics who affumed this name from Nicholas of Antioch; who, being a Gentile by birth, firft embraced Judaifm, and then Chriftianity; when his zeal and devotion recommended him to the church of Jerufalem, by whom he was chofen one of the firft deacons. Many of the primitive writers believe that Nicholas

cholas was rather the occafion than the author of the infamous practices of thofe who affumed his name, who were exprefsly condemned by the Spirit of God himfelf, Rev. ii. 6. And indeed their opinions and actions were highly extravagant and criminal. They allowed a community of wives, and made no diftinction between ordinary meats and thofe offered to idols. According to Eufebius, they fubfifted but a fhort time; but Tertullian fays that they only changed their name, and that their herefies paffed into the fect of the Cainians.

NICOLAS (St), an ifland of the Atlantic Ocean, and one of the moft confide.able of thofe of Cape Verde, lying between Santa Lucia and St Jago. It is of a triangular figure, and about 75 miles in length. The land is ftony, mountainous, and barren; but there are a great many goats in a valley inhabited by the Portuguefe. W. Long. 33. 35. N. Lat. 17. 0.

NICOLE (Peter), one of the fineft writers in Europe, was born at Chartres in 1625, of a confpicuous family. He adhered to the Janfenifts; and joined in the compofition of feveral works with Mr Arnauld, whofe faithful companion he was during the 10 or 12 years of his retirement. He gave a Latin tranflation of Pafcal's *Provinciales*, and added a commentary to them. One of his fineft works is his *Effais de Morale*. He wrote very fubtilely againft the Proteftants. His treatife on the unity of the church is efteemed a mafterly piece. He died at Paris in 1695, a few days after the publication of his treatife concerning the Quietifts. He was greatly fkilled in polite literature. To him is afcribed a collection of Latin epigrams, and of Greek, Spanifh, and Italian fentences, which has borne feveral impreffions, and has a learned preface to it.

NICOLO (St), the moft confiderable, ftrongeft, and beft peopled of the ifles of Tremeti in the gulf of Venice, to the eaft of St Domino, and to the fouth of Capparata. It has a harbour defended by feveral towers; and a fortrefs, in which is an abbey, with a very handfome church. E. Long. 15. 37. N. Lat. 42. 7.

NICOMEDES, the name of feveral kings of the ancient Bithynia. See BITHYNIA.

NICOMEDIA (anc. geogr.), metropolis of Bithynia, built by Nicomedes the grandfather of Prufias. Situated on a point of the Sinus Aftacenus, (Pliny); furnamed the *Beautiful*, (Athenæus): the largeft city of Bithynia, (Paufanias), who fays it was formerly called *Aftacus;* though Pliny diftinguifhes Aftacum and Nicomedia as different cities. Nicomedia was very famous, not only under its own kings, but under the Romans: the royal refidence of Dioclefian, and of Conftantine while Conftantinople was building, if we may credit Nicephorus. It is ftill called *Nicomedia*, at the bottom of a bay of the Propontis in the Hither Afia. E. Long. 30. 0. N. Lat. 41. 20. It is a place of confequence; carries on a trade in filk, cotton, glafs, and earthen-ware, and is the fee of a Greek archbifhop.

NICOPOLI, a town of Turkey in Europe, and in Bulgaria, famous for being the place where the firft battle was fought between the Turks and Chriftians in 1396; and where the latter were defeated with the lofs of 20,000 men. E. Long. 25. 33. N. Lat. 43. 46.

NICOSIA, the capital of the ifland of Cyprus, where a Turkifh bafhaw refides. It is delightfully fituated between the mountains of Olympus, and a chain of others; and was formerly well fortified by the Venetians; but the works are now in ruins. E. Long. 33. 35. N. Lat. 35. 1.

NICOT (John), lord of Vilemain, and mafter of requefts of the French king's houfehold, was born at Nifmes, and was fent ambaffador to Portugal in 1559; whence he brought the plant which, from his name, was called *Nicotiana*, but is now more known by the name of *tobacco*. He died at Paris in 1603. He wrote a French and Latin dictionary in folio; a treatife on navigation; and other works.

NICOTIANA, TOBACCO; a genus of the monogynia order, belonging to the pentandria clafs of plants. There are feven fpecies, of which the moft remarkable is the tabacum, or common tobacco-plant. This was firft difcovered in America by the Spaniards about the year 1560, and by them imported into Europe. It had been ufed by the inhabitants of America long before; and was called by thofe of the iflands *yoli*, and *pætun* by the inhabitants of the continent. It was fent into Spain from Tabaco, a province of Yucatan, where it was firft difcovered, and from whence it takes its common name. Sir Walter Raleigh firft introduced it into England about the year 1585, and was the firft who taught them how to fmoke it. Tobacco is commonly ufed among the oriental nations, though it is uncertain by whom it was introduced among them. Confiderable quantities of it are cultivated in the Levant, on the coafts of Greece and the Archipelago, in Italy, and in the ifland of Malta.

There are two varieties of that fpecies of Nicotiana which is cultivated for common ufe, and which are diftinguifhed by the names of *Oronokoe*, and *fweet-fcented tobacco*. They differ from each other only in the figure of their leaves; thofe of the former being longer and narrower than the latter. They are tall herbaceous plants, growing erect with fine foliage, and rifing with a ftrong ftem from fix to nine feet high. The ftalk, near the root, is upwards of an inch diameter, and furrounded with a kind of hairy or velvet clammy fubftance, of a yellowifh-green colour. The leaves are rather of a deeper green, and grow alternately at the diftance of two or three inches from each other. They are oblong, of a fpear-fhaped oval, and fimple; the largeft about 20 inches long, but decreafing in fize as they afcend, till they come to be only 10 inches long, and about half as broad. The face of the leaves is much corrugated, like thofe of fpinage when full ripe. Before they come to maturity, when they are about five or fix inches long, the leaves are generally of a full green, and rather fmooth; but as they increafe in fize, they become rougher, and acquire a yellowifh caft. The ftem and branches are terminated by large bunches of flowers collected into clufters, of a delicate red; the edges, when full-blown, inclining to a pale purple. They continue in fucceffion till the end of the fummer; when they are fucceeded by feeds of a brown colour, and kidney-fhaped. Thefe are very fmall, each capfule containing about 1000; and the

the whole produce of a ſingle plant is reckoned at about 350,000. The ſeeds ripen in the month of September.

Mr Carver informs us, that the Oronokoe, or, as it is called, the *long Virginia tobacco*, is the kind beſt ſuited for bearing the rigour of a northern climate, the ſtrength as well as the ſcent of the leaves being greater than that of the other. The *ſweet-ſcented* ſort flouriſhes moſt in a ſandy ſoil, and in a warm climate, where it greatly exceeds the former in the celerity of its growth; and is likewiſe, as its name intimates, much more mild and pleaſant.

Tobacco thrives beſt in a warm, kindly, rich ſoil, that is not ſubject to be over-run by weeds. In Virginia, the ſoil in which it thrives beſt is warm, light, and inclining to be ſandy; and therefore, if the plant is to be cultivated in Britain, it ought to be planted in a ſoil as nearly of the ſame kind as poſſible. Other kinds of ſoils might probably be brought to ſuit it, by a mixture of proper manure; but we muſt remember, that whatever manure is made uſe of muſt be thoroughly incorporated with the ſoil. The beſt ſituation for a tobacco plantation is the ſouthern declivity of a hill rather gradual than abrupt, or a ſpot that is ſheltered from the north winds: but at the ſame time it is neceſſary that the plants enjoy a free air; for without that they will not proſper.

As tobacco is an annual plant, thoſe who intend to cultivate it ought to be as careful as poſſible in the choice of the ſeeds; in which, however, with all their care, they may be ſometimes deceived. The ſeeds are to be ſown about the middle of April, or rather ſooner in a forward ſeaſon, in a bed prepared for this purpoſe of ſuch ſoil as hath been already deſcribed, mixed with ſome warm rich manure. In a cold ſpring, hot-beds are moſt eligible for this purpoſe, and gardeners imagine that they are always neceſſary: but Mr Carver tells us, that he is convinced, when the weather is not very ſevere, the tobacco-ſeeds may be raiſed without doors; and for this purpoſe gives us the following directions.

Treatiſe on the culture of Tobacco.

"Having ſown the feed in the manner above directed, on the leaſt apprehenſion of a froſt after the plants appear, it will be neceſſary to ſpread mats over the beds, a little elevated from the ground by poles laid acroſs, that they may not be cruſhed. Theſe, however, muſt be removed in the morning ſoon after the ſun appears, that they may receive as much benefit as poſſible from its warmth, and from the air. In this manner proceed till the leaves have attained about two inches in length, and one in breadth; which they will do in about a month after they are ſown, or near the middle of May, when the froſts are uſually at an end. One invariable rule for their being able to bear removal is, when the fourth leaf is ſprouted, and the fifth juſt appears. Then take the opportunity of the firſt rains or gentle ſhowers to tranſplant them into ſuch a ſoil and ſituation as before deſcribed; which muſt be done in the following manner.—The land muſt be ploughed, or dug up with ſpades, and made as mellow and light as poſſible. Where the plants are to be placed, raiſe with the hoe ſmall hillocks at the diſtance of two feet or a little more from each other, taking care that no hard ſods or lumps are in it; and then juſt indent the middle of each, without drilling holes, as for ſome other plants.

"When your ground is thus prepared, dig in a gentle manner from their native bed ſuch plants as have attained the proper growth for tranſplanting abovementioned; and drop, as you paſs, one on every hillock. Inſert a plant gently into each centre, preſſing the ſoil around it gently with your fingers; and taking the greateſt care, during the operation, that you do not break off any of the leaves, which are at this time exquiſitely tender. If the weather proves dry after they are thus tranſplanted, they muſt be watered with ſoft water, in the ſame manner as is uſually done to coleworts, or plants of a ſimilar kind. But though you now ſeem to have a ſufficient quantity of plants for the ſpace you intend to cultivate, it is yet neceſſary that you continue to attend to your bed of ſeedlings, that you may have enough to ſupply any deficiencies which through accident may ariſe. From this time great care muſt be taken to keep the ground ſoft and free from weeds, by often ſtirring with your hoe the mould round the roots; and to prune off the dead leaves that ſometimes are found near the bottom of the ſtalk.

"The difference of this climate from that in which I have been accuſtomed to obſerve the progreſs of this plant, will not permit me to direct with certainty the time which is moſt proper to take off the top of it, to prevent it from running to ſeed. This knowledge can only be acquired by experience. When it has riſen to the height of more than two feet, it commonly begins to put forth the branches on which the flowers and ſeeds are produced; but as this expanſion, if ſuffered to take place, would drain the nutriment from the leaves, which are the moſt valuable part, and thereby leſſen their ſize and efficacy, it becomes needful at this ſtage to nip off the extremity of the ſtalk to prevent its growing higher. In ſome other climates, the top is commonly cut off when the plant has 15 leaves; but if the tobacco is intended to be a little ſtronger than uſual, this is done when it has only 13; and ſometimes, when it is deſigned to be remarkably powerful, 11 or 12 are only allowed to expand. On the contrary, if the planter is deſirous of having his crop very mild, he ſuffers it to put forth 18 or 20: but in this calculation, the three or four lower leaves next the ground, which do not grow ſo large and fine as the others, are not to be reckoned.

"This operation, denominated *topping* the tobacco, is much better performed by the finger and thumb than with any inſtrument; becauſe the graſp of the fingers cloſes the pores of the plant; whereas, when it is done by inſtruments, the juices are in ſome degree exhauſted. Care muſt alſo be taken to nip off the ſprouts that will be continually ſpringing up at the junction of the leaves with the ſtalks. This is termed *ſuccouring*, or *ſuckering*, the tobacco; and ought to be repeated as often as occaſion requires.

"As it is impoſſible to aſcertain the due time for topping the plant, ſo it is equally impoſſible, without experiment, to aſcertain the time it will take to ripen in this country. The apparent ſigns of its maturity are theſe: The leaves, as they approach a ſtate of ripeneſs, become more corrugated or rough; and when fully ripe, appear mottled with yellowiſh ſpots on the raiſed parts; whilſt the cavities retain their uſual green colour.

They

Nicotiana. They are at this time alſo thicker than they have before been; and are covered with a downy velvet, like that formerly mentioned, on the ſtalks. If heavy rains happen at this critical period, they will waſh off this excreſcent ſubſtance, and thereby damage the plants. In this caſe, if the froſty nights are not begun, it is proper to let them ſtand a few days longer; when, if the weather be moderate, they will recover this ſubſtance again. But if a froſt unexpectedly happens during the night, they muſt be carefully examined in the morning, before the ſun has any influence upon them; and thoſe which are found to be covered with froſty particles, whether thoroughly ripe or not, muſt be cut up; for though they may not all appear to be arrived at a ſtate of maturity, yet they cannot be far from it, and will differ but little in goodneſs from thoſe that are perfectly ſo."

Tobacco is ſubject to be deſtroyed by a worm; and without proper care to exterminate this enemy, a whole field of plants may ſoon be loſt. This animal is of the horned ſpecies, and appears to be peculiar to the tobacco-plant; ſo that in many parts of America it is diſtinguiſhed by the name of the *tobacco-worm*. In what manner it is firſt produced, or how propagated, is unknown: but it is not diſcernible till the plants have attained about half their height; and then appears to be nearly as large as a gnat. Soon after this it lengthens into a worm; and by degrees increaſes in magnitude to the bigneſs of a man's finger. In ſhape it is regular from its head to its tail, without any diminution at either extremity. It is indented or ribbed round at equal diſtances, nearly a quarter of an inch from each other; and having at every one of theſe diviſions a pair of feet or claws, by which it faſtens itſelf to the plant. Its mouth, like that of the caterpillar, is placed under the fore-part of the head. On the top of the head, between the eyes, grows a horn about half an inch long, and greatly reſembling a thorn; the extreme part of which is of a brown colour, a firm texture, and the extremity ſharp-pointed. It is eaſily cruſhed; being only, to appearance, a collection of green juice incloſed in a membranaceous covering, without the internal parts of an animated being. The colour of its ſkin is in general green, interſperſed with ſeveral ſpots of a yellowiſh white; and the whole covered with a ſhort hair ſcarcely to be diſcerned. Theſe worms are found the moſt predominant during the latter end of July and the beginning of Auguſt; at which time the plants muſt be particularly attended to, and every leaf carefully ſearched. As ſoon as a wound is diſcovered, and it will not be long before it is perceptible, care muſt be taken to deſtroy the cauſe of it, who will be found near it, and from his unſubſtantial texture may eaſily be cruſhed: but the beſt method is to pull it away by the horn, and then cruſh it.

When the tobacco is fit for being gathered, as will appear from an attention to the foregoing directions, on the firſt morning that promiſes a fair day, before the ſun is riſen, take an ax or a long knife, and holding the ſtalk near the top with one hand, ſever it from its root with the other, as low as poſſible. Lay it gently on the ground, taking care not to break off the leaves, and there let it remain expoſed to the rays of the ſun throughout the day, or until the leaves, according to the American expreſſion, are entirely *wilted;* that is, till they become limber; and will bend any way without breaking. But if the weather ſhould prove rainy without any intervals of ſunſhine, and the plants appear to be fully ripe, they muſt be houſed immediately. This muſt be done, however, with great care, that the leaves, which are in this ſtate very brittle, may not be broken. They are next to be placed under proper ſhelter, either in a barn or covered hovel, where they cannot be affected by rain or too much air, thinly ſcattered on the floor; and if the ſun does not appear for ſeveral days, they muſt by left to will in that manner; but in this caſe the quantity of the tobacco will not be quite ſo good.

When the leaves have acquired the above-mentioned flexibility, the plants muſt be laid in heaps, or rather in one heap if the quantity is not too great, and in about 24 hours they will be found to ſweat. But during this time, when they have lain for a little while, and begin to foment, it will be neceſſary to turn them; bringing thoſe which are in the middle to the ſurface, and placing thoſe which are at the ſurface in the middle. The longer they lie in this ſituation, the darker-coloured is the tobacco; and this is termed *ſweating* the tobacco. After they have lain in this manner for three or four days, for a longer continuance might make the plants turn mouldy, they may be faſtened together in pairs with chords or wooden pegs, near the bottom of the ſtalk, and hung acroſs a pole, with the leaves ſuſpended in the ſame covered place, a proper interval being left between each pair. In about a month the leaves will be thoroughly dried, and of a proper temperature to be taken down. This ſtate may be aſcertained by their appearing of the ſame colour with thoſe imported from America. But this can be done only in wet weather. —The tobacco is exceedingly apt to attract the humidity of the atmoſphere, which gives it a pliability that is abſolutely neceſſary for its preſervation; for if the plants are removed in a very dry ſeaſon, the external parts of the leaves will crumble into duſt, and a conſiderable waſte will enſue.

As ſoon as the plants are taken down, they muſt again be laid in a heap, and preſſed with heavy logs of wood for about a week; but this climate may poſſibly require a longer time. While they remain in this ſtate, it will be neceſſary to introduce your hand frequently into the heap, to diſcover whether the heat be not too intenſe; for in large quantities this will ſometimes be the caſe, and conſiderable damage will be occaſioned by it. When they are found to heat too much, that is, when the heat exceeds a moderate glowing warmth, part of the weight by which they are preſſed muſt be taken away; and the cauſe being removed, the effect will ceaſe. This is called the *ſecond* or *laſt ſweating;* and, when completed, which it generally will be about the time juſt mentioned, the leaves may be ſtripped from the ſtalks for uſe. Many omit this laſt ſweating; but Mr Carver thinks that it takes away any remaining harſhneſs, and renders the tobacco more mellow. The ſtrength of the ſtalk alſo is diffuſed by it through the leaves, and the whole maſs becomes equally meliorated.—When the leaves are ſtripped from the ſtalks, they are to be tied up in bunches or *hands*, and kept in a cellar or other damp place; though if not handled in dry weather,

weather, but only during a rainy ſeaſon, it is of little conſequence in what part of the houſe or barn they are laid up. At this period the tobacco is thoroughly cured, and as proper for manufacturing with that imported from the colonies.

Our author adviſes the tobacco-planter, in his firſt trials, not to be too avaricious, but to top his plants before they have gained their utmoſt height; leaving only about the middle quantity of leaves directed before, to give it a tolerable degree of ſtrength. For tho' this, if exceſſive, might be abated during the cure by an increaſe of ſweating, or be remedied the next ſeaſon by ſuffering more leaves to grow, it can never be added, and, without a certain degree of ſtrength, the tobacco will always be taſteleſs, and of little value. On the contrary, though it be ever ſo much weakened by ſweating, and thereby rendered mild, yet it will never loſe the aromatic flavour which accompanied that ſtrength, and which greatly adds to its value. A ſquare yard of land, he tells us, will rear about 500 plants, and allow proper ſpace for their nurture till they are fit for tranſplanting.

Tobacco has ſometimes been preſcribed internally; in which caſe it proves violently cathartic and emetic, occaſioning almoſt intolerable cardialgic anxieties. By boiling in water its virulence is abated, and at length deſtroyed. An extract made by long coction is recommended by Stahl and other German phyſicians, as a ſafe and moſt effectual aperient, expectorant, detergent, &c. but this medicine, which, according to Dr Lewis, is extremely precarious and uncertain in ſtrength, has never come into eſteem in this country. Tobacco is ſometimes uſed externally in unguents for deſtroying cutaneous inſects, cleanſing old ulcers, &c. Beaten into a maſh with vinegar or brandy, it has ſometimes proved ſerviceable for removing hard tumours of the hypochondres: an account is given in the Edinburgh Eſſays of two caſes of this kind cured by it. The moſt common uſes of this plant, however, are, either as a ſternutatory when taken by way of ſnuff, as a maſticatory by chewing it in the mouth, or as effluvia by ſmoking it; and when taken in moderation, it is not an unhealthy amuſement. Before pipes were invented, it was uſually ſmoked in ſegars, and they are ſtill in uſe among ſome of the ſouthern nations. The method of preparing theſe is at once ſimple and expeditious: A leaf of tobacco being formed into a ſmall twiſted roll, ſomewhat larger than the ſtem of a pipe, and about eight inches long, the ſmoke is conveyed through the winding folds which prevent it from expanding, as through a tube; ſo that one end of it being lighted, and the other applied to the mouth, it is in this form uſed without much inconvenience. But, in proceſs of time, pipes being invented, they were found more commodious vehicles for the ſmoke, and are now in general uſe.

Among all the productions of foreign climes introduced into theſe kingdoms, ſcarce any has been held in higher eſtimation by perſons of every rank than tobacco. In the countries of which it is a native, it is conſidered by the Indians as the moſt valuable offering that can be made to the beings they worſhip. They uſe it in all their civil and religious ceremonies. When once the ſpiral wreaths of its ſmoke aſcend from the feathered pipe of peace, the compact that has been juſt made is conſidered as ſacred and inviolable. Likewiſe, when they addreſs their great Father, or his guardian ſpirits, reſiding as they believe in every extraordinary production of nature, they make liberal offerings to them of this valuable plant, not doubting but that they are thus ſecured of protection.

Tobacco is made up into rolls by the inhabitants of the interior parts of America by means of a machine called a *tobacco-wheel*. With this machine they ſpin the leaves, after they are cured, into a twiſt of any ſize they think fit; and having folded it into rolls of about 20 pounds each, they lay it by for uſe. In this ſtate it will keep for ſeveral years, and be continually improving, as it always grows milder. The Illinois uſually form it into carrots; which is done by laying a number of leaves, when cured, on each other, after the ribs have been taken out, and rolling them round with pack-thread till they become cemented together. Theſe rolls commonly meaſure about 18 or 20 inches long, and nine round in the middle part.

Tobacco forms a very conſiderable article in commerce; for an account of which ſee the articles GLASGOW and VIRGINIA.

NICTITATING MEMBRANE, a thin membrane chiefly found in the bird and fiſh kind, which covers the eyes of theſe animals, ſheltering them from the duſt or too much light; yet is ſo thin and pellucid, that they can ſee pretty well through it.

NIDUS, among naturaliſts, ſignifies a neſt, or proper repoſitory for the eggs of birds, inſects, &c. where the young of theſe animals are hatched and nurſed.

NIDIFICATION, a term generally applied to the formation of a bird's neſt, and its hatching or bringing forth its young. See ORNITHOLOGY.

NIECE, a brother's or ſiſter's daughter, which in the civil law is reckoned the third degree of conſanguinity.

NIEMEN, a large river of Poland, which riſes in Lithuania, where it paſſes by Bielica, Grodno, and Konno: it afterwards runs thro' part of Samogitia and Ducal Pruſſia, where it falls into the lake called the *Curiſch-haff*, by ſeveral mouths, of which the moſt northern is called the *Ruſs*, being the name of a town it paſſes by.

NIENBURG, a rich and ſtrong town of Germany, in the duchy of Brunſwic-Lunenburg, with a ſtrong caſtle. It carries on a conſiderable trade in corn and wool, and is ſeated in a fertile ſoil on the river Weſer. E. Long. 9. 26. N. lat. 52. 44.

NIEPER, a large river of Europe, and one of the moſt conſiderable of the North, formerly called the Boriſthenes. Its ſource is in the middle of Muſcovy, running weſt by Smolenſko, as far as Orſa; and then turns ſouth, paſſing by Mohilow, Bohaczo, Kiow, Czyrkaſſy, the fortreſs of Kudak, Deſſau, and Oczakow, falling into the Black Sea; as alſo in its courſe it divides Little Tartary from Budziac Tartary.

NIESTER, a large river of Poland, which has its ſource in the Lake Neiſter, in the palatinate of Lemburg, where it paſſes by Halicz. Then it ſeparates Podolia and Oczakow Tartary from Moldavia and Budziac Tartary; and falls into the Black Sea at Belgorod, between the mouths of the Nieper and the Danube.

Nieuwentyt ‖ Night.

NIEUWENTYT (Bernard), an able philofopher and learned mathematician, was born at Weftgraafdyk, in the year 1654, and became counfellor and burgomafter of the town of Purmerend, where he was efteemed for his integrity and learning, and died in 1718. He wrote, in Dutch, 1. An excellent treatife, intitled, The Exiftence of God demonftrated by the works of nature. 2. A refutation of Spinoza. 3. Some pieces againft the Infiniteffimals, &c.

NIGELLA, FENNEL-FLOWER, or *Devil in a bufh*; a genus of the pentagynia order, belonging to the polyandria clafs of plants. There are five fpecies, all of them natives of the warm parts of Europe, and rifing from a foot to a foot and an half high, adorned with blue or yellow flowers. They are propagated by feeds, which in a dry and warm fituation will thrive very well; and the plants ripen feeds in this country.

NIGER, a great river of Africa, fuppofed to have its origin near that of the Nile; but this is very uncertain. We are affured, however, that it is a river of very great extent: efpecially if we fuppofe, according to the opinion of the beft modern geographers, that it has its fource in the kingdom of Gorhan, not far from the confines of Upper Ethiopia; for then it will crofs almoft the whole continent of Africa, where it is wideft. In its courfe it receives many confiderable rivers, which fwell it high enough to be able at all times to carry veffels of good burden; fo it fplits itfelf into feveral branches, which uniting again form very large and fertile iflands, well filled with towns and villages. It paffes alfo through feveral lakes, and has many cataracts. After having run from eaft to weft, during a prodigious long courfe, it turns at laft fhort to the fouth, at a leagne and a half diftance from the weftern ocean; leaving but a very narrow tract between it and the fea, into which it opens its way in lat. 15. 55. after having run about 25 leagues from north to fouth. Its mouth is fometimes half a league broad; but is fhut up by a bank of quick-fand called the *bar of Senegal*, where the water is fo fhallow, that it is very difficult and dangerous to pafs over it. The bar is formed by the mud and fand which the river brings with it during the inundation, and which the fea continually drives back upon the fhore. This would effectually exclude all fhipping, had not the violence of the current, and the weight of the waters, made two openings or channels, which are commonly called the *paffes of the bar*. The largeft of thefe is generally not above 150 or 200 fathoms broad, and about 10 feet deep, fo that none but barks of 40 or 50 tons can get through this channel; the other is fo narrow and fhallow, that it is paffable by canoes only. Thefe channels are not always in the fame place; for the river, as it is more or lefs fwelled, or the current more or lefs rapid, opens thofe paffes fometimes in one place, and fometimes in another. The bar itfelf alfo frequently fhifts its place; fo that the ifland of Senegal is fometimes four leagues diftant from it, at other times only two. It is this bar only which hinders fhips of 400 or 500 tons to go up the river.

NIGHT, that part of the natural day during which the fun is underneath the horizon; or that fpace wherein it is dufky.

Night was originally divided by the Hebrews and other eaftern nations into three parts or watches. The Romans, and after them the Jews, divided the night into four parts or watches; the firft of which began at funfet, and lafted till nine at night, according to our way of reckoning; the fecond lafted till midnight; the third till three in the morning; and the fourth ended at funrife. The ancient Gauls and Germans divided their time not by days but nights; and the people of Iceland and the Arabs do the fame at this day. The like is obferved of the Anglo-Saxons.

Night, Nightingale.

NIGHT-*Angling*, a method of catching large and fhy fifh in the night-time. Trout, and many other of the better forts of fifh, are naturally fhy and fearful; they therefore prey in the night as the fecureft time.—The method of taking them on this plan is as follows. The tackle muft be ftrong, and need not be fo fine as for day-fifhing, when every thing is feen; the hook muft be baited with a large earth-worm, or a black fnail, and thrown out into the river; there muft be no lead to the line, fo that the bait may not fink, but be kept drawling along, upon or near the furface. Whatever trout is near the place will be brought thither by the motion of the water, and will feize the worm or fnail. The angler will be alarmed by the noife which the fifh makes in rifing, and is to give him line, and time to fwallow the hook; then a flight touch fecures him. The beft and largeft trouts are found to bite thus in the night; and they rife moftly in the ftill and clear deeps, not in the fwift and fhallow currents. Sometimes, though there are fifh about the place, they will not rife at the bait; in this cafe the angler muft put on fome lead to his line, and fink it to the bottom.

NIGHT-*Mare*, or *Incubus*. See MEDICINE, n° 430.

NIGHT-*Walkers*, in medicine. See NOCTAMBULI.

NIGHT-*Walkers*, in law, are fuch perfons as fleep by day and walk by night, being oftentimes pilferers or difturbers of the public peace. Conftables are authorifed by the common law to arreft night-walkers and fufpicious perfons, &c. Watchmen may alfo arreft night-walkers, and hold them until the morning: and it is faid, that a private perfon may arreft any fufpicious night-walker, and detain him till he give a good account of himfelf. One may be bound to the good behaviour for being a night-walker; and common night-walkers, or haunters of bawdy-houfes, are to be indicted before juftices of peace, &c. But it is not held lawful for a conftable, &c. to take up any woman as a night-walker on bare fufpicion only of being of ill fame, unlefs fhe be guilty of a breach of the peace, or fome unlawful act, and ought to be found mifdoing. *Blackft. Comment.*

NIGHTINGALE, in ornithology; a fpecies of MOTACILLA; under which article it happened to be omitted.

The nightingale takes its name from *night*, and the Saxon word *galan*, " to fing;" expreffive of the time of its melody. In fize it is equal to the redftart; but longer-bodied, and more elegantly made. The colours are very plain. The head and back are of a pale tawny, dafhed with olive: the tail is of a deep tawny red: the throat, breaft, and upper part of the belly, of a light gloffy afh-colour: the lower belly almoft white: the exterior webs of the quill-feathers are of a dull reddifh brown; the interior of brownifh afh-colour: the irides are hazel, and the eyes remarkably large

large and piercing: the legs and feet a deep ash-colour.

This bird, the most famed of the feathered tribe, for the variety, length, and sweetness of its notes, visits England the beginning of April, and leaves us in August. It is a species that does not spread itself over the island. It is not found in North Wales; or in any of the English counties north of it, except Yorkshire, where they are met with in great plenty about Doncaster. They have been also heard, but rarely, near Shrewsbury. It is also remarkable, that this bird does not migrate so far west as Devonshire and Cornwall; counties where the seasons are so very mild, that myrtles flourish in the open air during the whole year: neither are they found in Ireland. Sibbald places them in his list of Scotch birds; but they certainly are unknown in that part of Great Britain, probably from the scarcity and the recent introduction of hedges there. Yet they visit Sweden, a much more severe climate. In England they frequent thick hedges, and low coppices; and generally keep in the middle of the bush, so that they are very rarely seen. They form their nest of oak leaves, a few bents and reeds. The eggs are of a deep brown. When the young ones first come abroad, and are helpless, the old birds make a plaintive and jarring noise with a sort of snapping as if in menace, pursuing along the hedge the passengers.

They begin their song in the evening, and continue it the whole night These their vigils did not pass unnoticed by the ancients: the slumbers of these birds were proverbial; and not to rest as much as the nightingale, expressed a very bad sleeper (A). This was the favourite bird of the British poet, who omits no opportunity of introducing it, and almost constantly noting its love of solitude and night. How finely does it serve to compose part of the solemn scenery of his *Penseroso;* when he describes it

In her saddest sweetest plight,
Smoothing the rugged brow of night;
While *Cynthia* checks her dragon yoke,
Gently o'er th' accustom'd oak.
Sweet bird, that shunn'st the noise of folly,
Most musical, most melancholy!
Thee, chauntress, oft the woods among,
I woo to hear thy evening song.

In another place he styles it the *solemn bird;* and again speaks of it,

As the wakeful bird
Sings darkling, and, in shadiest covert hid,
Tunes her nocturnal note.

The reader will excuse a few more quotations from the same poet, on the same subject; the first describes the approach of evening, and the retiring of all animals to their repose.

Silence accompanied; for beast and bird,
They to their grassy couch, these to their nests
Were slunk; all but the wakeful *nightingale*,
She all night long her amorous descant sung.

When Eve passed the irksome night preceding her fall, she, in a dream, imagines herself thus reproached with losing the beauties of the night by indulging too long a repose.

Why sleep'st thou, *Eve?* now is the pleasant time,
The cool, the silent, save where silence yields
To the night-warbling bird, that now awake
Tunes sweetest his love-labour'd song.

The same birds sing their nuptial song, and lull them to rest. How rapturous are the following lines! how expressive of the delicate sensibility of our Milton's tender ideas!

The earth
Gave sign of gratulation, and each hill;
Joyous the birds; fresh gales and gentle airs
Whisper'd it to the woods, and from their wings
Flung rose, flung odours from the spicy shrub,
Disporting, till the amorous bird of night
Sung sponsal, and bid haste the evening star
On his hill-top to light the bridal lamp.
These, lull'd by *nightingales*, embracing slept;
And on their naked limbs the flowery roof
Shower'd roses, which the morn repair'd.

These quotations from the best judge of melody, we thought due to the sweetest of our feathered choiristers; and we believe no reader of taste will think them tedious.

Virgil seems to be the only poet among the ancients who hath attended to the circumstance of this bird's singing in the night time.

Qualis populeâ mœrens Philomela *sub umbrâ*
Amissos queritur fœtus, quos durus arator
Observans nido implumes detraxit: at illa
Flet noctem, ramoque sedens miserabile carmen
Integrat, et mœstis late loco questibus implet.
Georg. IV. l. 511.

As *Philomel* in poplar shades, alone,
For her lost offspring pours a mother's moan,
Which some rough ploughman marking for his prey,
From the warm nest, unfledg'd hath dragg'd away;
Percht on a bough, she all night long complains,
And fills the grove with sad repeated strains. *F. Warton.*

Pliny has described the warbling notes of this bird, with an elegance that bespeaks an exquisite sensibility of taste, *lib.* x. *c.* 29.

If the nightingale is kept in a cage, it often begins to sing about the latter end of November, and continues its song more or less till June.—A young canary-bird, linnet, sky-lark, or robin (who have never heard any other bird), are said best to learn the note of a nightingale.

NIGHTSHADE, in botany. See SOLANUM.

Deadly NIGHTSHADE. See ATROPA. The berries of this plant are of a malignant poisonous nature; and, being of a sweet taste, have frequently proved destructive to children. A large glass of warm vinegar, taken as soon as possible after eating the berries, will prevent their bad effects.

NIGIDIUS FIGULUS (Publius), one of the most learned men of ancient Rome, flourished at the same time with Cicero. He wrote on various subjects; but his pieces appeared so refined and difficult, that they were not regarded. He assisted Cicero, with great prudence, in defeating Catiline's conspiracy, and did him many services in the time of his adversity. He adhered to Pompey, in opposition to Cæsar; which occasioned his exile, he dying in banishment. Cicero, who had always entertained the highest esteem for him, wrote a beautiful consolatory letter to him, (the 13th of *lib.* 4. *ad Familiares.*)

NIGRITIA. See NEGROLAND.

NILE, a great river of Egypt in Africa, which has

(A) *Ælian var. hist.* 577. both in the text and note. It must be remarked, that nightingales sing also in the day.

has its fource in Abyffinia, in about eight degrees north latitude. It runs generally from fouth to north through Abyffinia, Senna, and Nubia, into Egypt in one ftream, till it comes below Cairo to the Delta, where it divides into feveral branches, the two principal of which difcharge themfelves into the Mediterranean, the one at Damietta, and the other at Rofetta. There are feveral cataracts in this river in Upper Egypt, but not fo dreadful as ancient authors have reported. There are great rejoicings every year in Egypt when the Nile rifes to a certain height, becaufe their future harveft depends upon it. At the time of its rifing they publifh every day how many cubits and inches it is rifen. But to know this, we muft remember, that each cubit contains 24 inches: when the water is augmented to 16 cubits, then they open a fluice, which runs crofs the city of Cairo; and when it is come to 22 cubits, it is reckoned very advantageous, if it afcends no higher: but if it rifes to 24, it puts them into a terrible confternation, and then they publifh that it extends from one mountain to the other. They are likewife in a great fright when the water afcends very flowly, becaufe they are then afraid that it will not rife high enough to render the land fertile. The inundation generally continues from the 20th of July to the beginning of November; at which time the dry land begins to appear, if it can be called dry, after it has been fo long foaked in the water. As foon as the land is fit, they fow their corn, and in April it becomes yellow and fit for reaping. When the water is let into the great canal, it is conveyed from thence into refervoirs and cifterns, to be diftributed into their fields and gardens. But all the low wet places are fowed with rice, which grows beft in the water. This overflowing of the Nile is owing to the great rains which fall annually between the tropics upon the high mountains of Abyffinia, near which the fource of the Nile is, and from which the water falls down in great torrents into that river. The Nile does not contain a great number of fifh, perhaps becaufe there are fo many crocodiles and other voracious animals. The water, when it is clear, is very fit for drinking.

NIMBUS, in antiquity, a circle obferved on certain medals, or round the heads of fome emperors; anfwering to the circles of light drawn round the images of faints.

NIMEGUEN, a large, handfome, and ftrong town of the Netherlands, and capital of Dutch Guelderland, with a citadel, an ancient palace, and feveral forts. It is noted for the peace concluded there in 1679. It has a magnificent town-houfe, and the inhabitants are greatly addicted to trade. It is feated on the Vahal or Wahal, between the Rhine and the Maefe, in Long. 5. 50. Lat. 51. 55.

NIMETULAHITES, a kind of Turkifh monks, fo called from their founder Nimetulahi, famous for his doctrines and the aufterity of his life.

NIMPO, a city and fea-port town of China, in the province of Chekiang. It is feated on the eaftern fea of China, over-againft Japan. It is a city of the firft rank, and ftands at the confluence of two fmall rivers, which, after their union, form a channel that reaches to the fea, and is deep enough to bear veffels of 200 tons burthen. The walls of Nimpo are 5000 paces in circumference, and are built with free-ftone. There are five gates, befides two water-gates for the paffage of barks into the city; a tower feveral ftories high, built of bricks; and a long bridge of boats, faftened together with iron chains, over a very broad canal. This city is commanded by a citadel built on a very high rock, by the foot of which all veffels muft neceffarily pafs. The Chinefe merchants of Siam and Batavia go to this place yearly to buy filks, which are the fineft in the empire. They have alfo a great trade with Japan, it being but two days fail from hence: thither they carry filks, ftuffs, fugar, drugs, and wine; and bring back copper, gold, and filver. E. Long. 122. 0. N. Lat. 30. 0.

NINEVEH (anc. geogr.), a city of Affyria, which is thought to be one of the moft ancient in the world. It was enlarged by Ninus, who fome take to be the *Nimrod* of Mofes. When Jonas went to preach againft it, he was faid to be three days in paffing through it. It was a long while the capital of the Affyrian empire; but is now ruined, and it is hard to find the place where it ftood.

NINON LENCLOS, a celebrated lady in the court of France, was of a noble family, and born at Paris in the year 1615; but rendered herfelf famous by her wit and gallantries. Her mother was a lady of exemplary piety; but her father early infpired her with the love of pleafure. Having loft her parents at 14 years of age, and finding herfelf miftrefs of her own actions, fhe refolved never to marry: fhe had an income of 10,000 livres a-year; and, according to the leffons fhe had received from her father, drew up a plan of life and gallantry, which fhe purfued till her death. Never delicate with refpect to the number, but always in the choice, of her pleafures, fhe facrificed nothing to intereft; but loved only while her tafte for it continued; and had among her admirers the greateft lords of the court. But though fhe was light in her amours, fhe had many virtues.—She was conftant in her friendfhips; faithful to what are called the *laws of honour;* of ftrict veracity; difinterefted; and more particularly remarkable for the exacteft probity. Women of the moft refpectable characters were proud of the honour of having her for their friend: at her houfe was an affemblage of every thing moft agreeable in the city and the court; and mothers were extremely defirous of fending their fons to that fchool of politenefs and good tafte, that they might learn fentiments of honour and probity, and thofe other virtues that render men amiable in fociety. But the illuftrious Madame de Sevigné with great juftice remarks in her letters, that this fchool was dangerous to religion and the Chriftian virtues; becaufe Ninon Lenclos made ufe of feducing maxims, capable of depriving the mind of thofe invaluable treafures. Ninon was efteemed beautiful, even in old age; and is faid to have infpired violent paffions at 80. She died at Paris in 1705. This lady had feveral children; one of whom, named *Chevalier de Villiers,* occafioned much difcourfe by the tragical manner in which he ended his life. He became in love with Ninon, without knowing that fhe was his mother; and when he difcovered the fecret of his birth, ftabbed himfelf in a fit of defpair. There have been publifhed the pretended Letters of Ninon Lenclos to the marquis de Sevigné.

NINTH, in mufic. See INTERVAL.

NINUS, the firft king of the Affyrians, was, it is faid, the fon of Belus. It is added, that he enlarged Nineveh and Babylon; conquered Zoroafter king of the Bactrians; married Semiramis of Afcalon; fubdued almoft all Afia; and died after a glorious reign of 52 years, about 1150 B. C.; but all thefe facts are uncertain. See SEMIRAMIS.

NIO, an ifland of the Archipelago, between Naxi to the north, Armago to the eaft, Santerino to the fouth, and Sikino to the weft, and is about 35 miles in circumference. It is remarkable for nothing but Homer's tomb, which they pretend is in this ifland; for they affirm that he died here in his paffage from Samos to Athens. The ifland is well cultivated, and not fo fteep as the other iflands, and the wheat which it produces is excellent; but oil and wood are fcarce. It is fubject to the Turks. E. Long. 25. 53. N. Lat. 36. 35.

NIOBE, in fabulous hiftory, the daughter of Tantalus, and the wife of Amphion king of Thebes, was a princefs of great beauty; but being the mother of feven fons and as many daughters, fhe had the prefumption to prefer herfelf to Latona, who had only Apollo and Diana. Latona enraged at this contempt, caufed Apollo and Diana to kill Niobe's 14 children with their arrows, the former flaying the fons, and the latter the daughters, in the embraces of their mother. On which Niobe being filled with the deepeft grief, Jupiter, in compaffion to her inceffant tears, turned her into ftone.

NIPHON, the largeft of the Japan iflands, being 600 miles long, and 100 broad. See JAPAN.

NIPPERS, in the menage, are four teeth in the fore-part of a horfe's mouth, two in the upper, and two in the lower jaw. A horfe puts them forth between the fecond and third year.

NIPPLES, in anatomy. See there, n° 376, c.

NIPPLE-WORT, in botany. See LAPSANA.

NISI PRIUS, in law, a judicial writ which lies in cafes where the jury being impanelled and returned before the juftices of the bank, one of the parties requefts to have fuch a writ for the eafe of the country, in order that the trial may come before the juftices in the fame county on their coming thither. The purport of a writ of *nifi prius* is, that the fheriff is thereby commanded to bring to Weftminfter the men impanelled, at a certain day, before the juftices, "*nifi prius jufticiarii domini regis ad affifas capiendas venerint.*"

NISIBIS (anc. geog.), a city both very ancient and noble, fituate in a diftrict called *Mygdonia*, in the north of Mefopotamia, towards the Tigris, from which it is diftant two days journey. Some afcribe its origin to Nimrod, and fuppofe it to be the *Achad* of Mofes. The Macedonians called it *Antiochia of Mygdonia*, (Plutarch); fituate at the foot of mount Mafius, (Strabo). It was the Roman bulwark againft the Parthians and Perfians, down to the emperor Jovianus; who, by an ignominious peace, delivered it up to the Perfians. A colony, called *Septimia Nefibitana.*— Another *Nifibis*, of Aria, (Ptolemy), near the lake Arias.

NISMES, an ancient, large, and flourifhing town of France, in Languedoc, with a bifhop's fee, and an academy. There are feveral monuments of antiquity, of which the amphitheatre is the principal, built by the Romans. The *maifon quarrée*, or the fquare-houfe, is a piece of architecture of the Corinthian order, and one of the fineft in the world. The temple of Diana is in part gone to ruin. It was taken by the Englifh in 1417. The inhabitants were all Calvinifts; but Lewis XIV. demolifhed their church in 1685, and built a caftle to keep them in awe. It is feated in a delightful plain, abounding in wine, oil, game, and cattle. E. Long. 4. 26. N. Lat. 43. 50.

NITHSDALE, NITHISDALE, or *Niddifdale*, a divifion of Dumfriesfhire in Scotland, lying to the weftward of Anandale. It is a large and mountainous tract, deriving its name from the river Nid, which iffues from a lake called *Loch-cure*, runs by the towns of Sanquhar, Morton, and Drumlanrig, and difcharges itfelf into the Solway Frith. This country was formerly fhaded with noble forefts, which are now almoft deftroyed; fo that, at prefent, nothing can be more naked, wild, and favage. Yet the bowels of the earth yields lead, and, as is faid, filver and gold: the mountains are covered with fheep and black cattle; and here are ftill fome confiderable remains of the ancient woods, particularly that of Holywood, three miles from Dumfries, noted for an handfome church built out of the ruins of an ancient abbey; and alfo for being the birth-place of the famous aftrologer, hence called *Joannes de Sacro Bofco.*

NITRE, or SALTPETRE. See CHEMISTRY, n° 184.

Calcareous NITRE. Ibid. n° 191.

Cubic NITRE. Ibid. n° 185.

NITROUS, any thing impregnated with nitre.

NITROUS *Air*. See AIR, n° 36, 39.; EUDIOMETER, note (B); and AIR, in the APPENDIX.

NIVELLE, a town of the Auftrian Netherlands, in the province of Brabant, remarkable for its abbey of Canoneffes. Here is a manufacture of cambrics, and the town enjoys great privileges. The abbey juft mentioned is inhabited by young ladies of the firft quality, who are not confined therein as in nunneries, but may go out and marry whenever they fee convenient, or a proper match offers. E. Long. 4. 20. N. Lat. 50. 46.

NIVELLE *de la Chauffée* (Peter Claude), a comic poet, born at Paris; acquired great reputation by inventing a new kind of entertainment, which was called *the Weeping Comedy.* Inftead of imitating Ariftophanes, Terence, Moliere, and the other celebrated comic poets who had preceded him; and inftead of exciting laughter by painting the different ridiculous characters, giving ftrokes of humour and abfurdities in conduct; he applied himfelf to reprefent the weakneffes of the heart, and to touch and foften it. In this manner he wrote five comedies: 1. *La fauffe Antipathie.* 2. *Le Préjugé à la Mode;* this piece met with great fuccefs. 3. *Mélanide.* 4. *Amour pour Amour;* and, 5. *L'Ecole des Meres.* He was received into the French academy in 1736; and died at Paris in 1754, at 63 years of age. He alfo wrote a tragedy, intitled, *Maximianus;* and an epiftle to Clio, an ingenious didactic poem.

NIVERNOIS, a province of France, with the title of a *duchy*, between Burgundy, Bourbonnois, and Barri. It is pretty fertile in wine, fruit, and corn; except the part

part called *Morvant*, which is a mountainous country, and barren. There is agreat deal of wood, and feveral iron mines; as alfo mines of pit-coal, which ferves to work their forges. This province is watered by a great number of rivers; of which the Allier, the Loire, and the Yonne, are navigable. Nevers is the capital city.

NIXAPA, a rich and confiderable town in New Spain, with a rich convent of Dominicans. The country about it abounds in cochineal, indigo, and fugar. E. Long. 97. 25. N. Lat. 15. 20.

NO, (Jeremiah, Ezekiel), No-Ammon, (Nahum); a confiderable city of Egypt, thought to be the name of an idol which agrees with Jupiter-Ammon. The Septuagint tranflate the name in Ezekiel, *Diofpolis*, "the city of Jupiter." Bochart takes it to be *Thebes* of Egypt; which, according to Strabo and Ptolemy, was called *Diofpolis*. Jerome, after the Chaldee paraphraft Jonathan, fuppofes it to be Alexandria, named by way of anticipation; or an ancient city of that name is fuppofed to have ftood on the fpot where Alexandria was built.

No-*Man's-Land*, a fpace between the after-part of the belfrey and the fore-part of a fhip's boat, when the faid boat is ftowed upon the booms, as in a deep-waifted veffel. Thefe booms are laid from the forecaftle nearly to the quarter-deck, where their after-ends are ufually fuftained by a frame called the *gallows*, which confifts of two ftrong pofts, about fix feet high, with a crofs piece reaching from one to the other, athwart-fhips, and ferving to fupport the ends of thofe booms, mafts, and yards, which lie in referve to fupply the place of others carried away, &c. The fpace called *No-man's-land* is ufed to contain any blocks, ropes, tackles, &c. which may be neceffary on the forecaftle. It probably derives this name from its fituation, as being neither on the ftarboard nor larboard fide of the fhip, nor on the waift or forecaftle; but, being fituated in the middle, partakes equally of all thofe places.

NOAH, a famous patriarch, was the fon of Lamech, and was born in 2978 B.C. He alone with his family were preferved from the univerfal deluge, when God exterminated the reft of the human race on account of their crimes. Having by the divine command built an ark, he entered it with his wife, his three fons and their wives, and animals of every kind, who were to multiply upon the earth after the deluge. Noah and all the living creatures ftaid a year in that veffel; and, on his coming out, he immediately expreffed his gratitude by erecting an altar to the Lord, and offering facrifices.—On which God bleffed Noah and his family, and promifed that the waters fhould no more overflow the whole earth. He died at the age of 950, 350 years after the deluge; leaving three fons, Shem, Ham, and Japheth, from whom fprung the whole human race.

NOBILIARY, in literary hiftory, a book containing the hiftory of the noble families of a nation, or province: fuch are Choriere's Nobiliary of Dauphine, and Caumartin's Nobiliary of Provence. The Germans are faid to be particularly careful of their Nobiliaries, in order to keep up the dignity of their families.

NOBILITY, a quality that ennobles, and raifes a perfon poffeffed of it above the rank of a commoner.

The origin of nobility in Europe is by fome referred to the Goths; who, after they had feized a part of Europe, rewarded their captains with titles of honour, to diftinguifh them from the common people.—In this place we fhall confider the manner in which they may be created, and the incidents attending them.

1. The right of peerage feems to have been originally territorial; that is, annexed to lands, honours, caftles, manors, and the like, the proprietors and poffeffors of which were (in right of thofe eftates) allowed to be peers of the realm, and were fummoned to parliament to do fuit and fervice to their fovereign: and, when the land was alienated, the dignity paffed with it as appendant. Thus the bifhops ftill fit in the houfe of lords in right of fucceffion to certain ancient baronies annexed, or fuppofed to be annexed, to their epifcopal lands; and thus, in 11 Hen. VI. the poffeffion of the caftle of Arundel was adjudged to confer an earldom on its poffeffor. But afterwards, when Alienations grew to be frequent, the dignity of peerage was confined to the lineage of the party ennobled, and inftead of territorial became perfonal. Actual proof of a tenure by barony became no longer neceffary to conftitute a lord of parliament; but the record of the writ of fummons to him or his anceftors was admitted as a fufficient evidence of the tenure.

Peers are now created either by writ or by patent: for thofe who claim by prefcription muft fuppofe either a writ or patent made to their anceftors; tho' by length of time it is loft. The creation by writ, or the king's letter, is a fummons to attend the houfe of peers, by the ftyle and title of that barony which the king is pleafed to confer: that by patent is a royal grant to a fubject of any dignity and degree of peerage. The creation by writ is the more ancient way; but a man is not ennobled thereby, unlefs he actually take his feat in the houfe of lords: and fome are of opinion that there muft be at leaft two writs of fummons, and a fitting in two diftinct parliaments, to evidence an hereditary barony: and therefore the moft ufual, becaufe the fureft, way is to grant the dignity by patent, which endures to a man and his heirs according to the limitations thereof, though he never himfelf makes ufe of it. Yet it is frequent to call up the eldeft fon of a peer to the houfe of lords by writ of fummons, in the name of his father's barony: becaufe in that cafe there is no danger of his children's lofing the nobility in cafe he never takes his feat; for they will fucceed to their grandfather. Creation by writ has alfo one advantage over that by patent: for a perfon created by writ holds the dignity to him and his heirs, without any words to that purport in the writ; but in latters patent there muft be words to direct the inheritance, elfe the dignity endures only to the grantee for life. For a man or woman may be created noble for their own lives, and the dignity not defcend to their heirs at all, or defcend only to fome particular heirs: as where a peerage is limited to a man and the heirs male of his body by Elizabeth his prefent lady, and not to fuch heirs by any former or future wife.

Blackft. Comment.

2. Let us next take a view of a few of the principal incidents attending the nobility,—exclufive of their capacity

Nobility. capacity as members of parliament, and as hereditary counsellors of the crown, both of which we have considered under the articles LORDS and PARLIAMENT. And first we must observe, that in criminal cases a nobleman shall be tried by his peers. The great are always obnoxious to popular envy: were they to be judged by the people, they might be in danger from the prejudice of their judges; and would moreover be deprived of the privilege of the meanest subjects, that of being tried by their equals, which is secured to all the realm by magna carta, c. 29. It is said, that this does not extend to bishops; who, though they are lords of parliament, and sit there by virtue of their baronies which they hold *jure ecclesiæ*, yet are not ennobled in blood, and consequently not peers with the nobility. As to peeresses, no provision was made for their trial when accused of treason or felony, till after Eleanor duchess of Gloucester, wife to the lord protector, had been accused of treason, and found guilty of witchcraft, in an ecclesiastial synod, through the intrigues of cardinal Beaufort. This very extraordinary trial gave occasion to a special statute, 20 Hen. VI. c. 9. which enacts, that peeresses, either in their own right or by marriage, shall be tried before the same judicature as peers of the realm. If a woman, noble in her own right, marries a commoner, she still remains noble, and shall be tried by her peers: but if she be only noble by marriage, then by a second marriage with a commoner she loses her dignity; for by marriage it is gained, by marriage it is also lost. Yet if a duchess-dowager marries a baron, she continues a duchess still; for all the nobility are *pares*, and therefore it is no degradation. A peer or peeress (either in her own right or by marriage) cannot be arrested in civil cases: and they have also many peculiar privileges annexed to their peerage in the course of judicial proceedings. A peer sitting in judgment, gives not his verdict upon oath, like an ordinary juryman, but upon his honour; he answers also to bills in chancery upon his honour, and not upon his oath; but, when he is examined as a witness either in civil or criminal cases, he must be sworn; for the respect which the law shews to the honour of a peer does not extend so far as to overturn a settled maxim, that *in judicio non creditur nisi juratis*. The honour of peers is however so highly tendered by the law, that it is much more penal to spread false reports of them, and certain other great officers of the realm, than of other men: scandal against them being called by the peculiar name of *scandalum magnatum*, and subjected to peculiar punishment by divers ancient statutes.

A peer cannot lose his nobility but by death or attainder; though there was an instance, in the reign of Edward the fourth, of the degradation of George Nevile duke of Bedford by act of parliament, on account of his poverty, which rendered him unable to support his dignity. But this is a singular instance: which serves at the same time, by having happened, to shew the power of parliament; and, by having happened but once, to shew how tender the parliament hath been, in exerting so high a power. It hath been said indeed, that if a baron wastes his estate, so that he is not able to support the degree, the king may degrade him: but it is expresly held by later authorities, that a peer cannot be degraded but by act of parliament.

Noble ‖ Nocturnal.

NOBLE, a money of account containing six shillings and eight pence.

The noble was anciently a real coin struck in the reign of Edward III. and then called the *penny of gold;* but it was afterwards called a *rose-noble*, from its being stamped with a rose: it was current at 6s. 8d.

NOCERA, an ancient town of Italy, in the duchy of Spoletto, and in the territory of the pope, with a bishop's see; seated at the foot of the Appennines, E. Long. 12. 55. N. Lat. 43. 2.

Terra NOCERIANA, *Earth of Nocera*, in the materia medica, a species of bole remarkably heavy, of a greyish-white colour, of an insipid taste, and generally with some particles in it which grit between the teeth. It is much esteemed by the Italians, as a remedy for venomous bites, and in fevers; but, excepting as an absorbent and astringent, no dependence is to be had on it.

NOCTAMBULI, NOCTAMBULONES, or *Night-walkers;* a term of equal import with *somnambuli*, applied to persons who have a habit of rising and walking about in their sleep. The word is a compound of the Latin *nox*, "night," and *ambulo*, "I walk."

Schenckius, Horstius, Clauderus, and Hildanus, who have wrote of sleep, give us divers unhappy histories of such noctambuli. When the disease is moderate, the persons affected with it only repeat the actions of the day on getting out of bed, and go quietly to the places they frequented at other times; but those who have it in the most violent degree, go up to dangerous places, and do things which would terrify them to think of when they are awake. These are by some caled *lunatic* night-walkers, because fits are observed to return with the most frequency and violence at the changes of the moon.—For the cure some recommend purging and a cooling regimen: others are of opinion that the best method is to place a vessel of water at the patient's bed-side in such a manner that he will naturally step into it when he gets out of bed; or if that should fail, a person should sit up to watch and beat him every time it happens.

NOCTILUCA, a species of phosphorus, so called because it shines in the dark without any light being thrown upon it: such is the phosphorus made of urine.

NOCTURNAL, something relating to the night, in contradiction to diurnal.

NOCTURNAL, *Nocturlabium*, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night.

Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole star, and the pointers of the great bear.

This instrument consists of two circular plates, applied to each other. The greater, which has a handle to hold the instrument, is about $2\frac{1}{2}$ inches diameter, and is divided into twelve parts, agreeing to the twelve months; and each month subdivided into every fifth

fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth to be told in the night. Those at the hours 12, are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, viz. the two circles and index, are joined by a rivet which is pierced through the centre with a hole, through which the star is to be observed.

Plate CCI. fig. 2.

To use the nocturnal, turn the upper plate till the long tooth, marked 12, be against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle with the plane nearly parallel to the equinoctial; and viewing the pole star through the hole of the centre, turn the index about, till, by the edge coming from the centre, you see the bright star or guard of the little bear, (if the instrument be fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour-circle: which may be known without a light, by counting the teeth from the longest, which is for the hour 12.

NODATED HYPERBOLA, a name given by Sir Isaac Newton to a kind of hyperbola, which, by turning round, decussates or crosses itself.

NODE, a tumour arising on the bones, and usually proceeding from some venereal cause; being much the same with what is otherwise called *exostosis*.

NODES, in astronomy, the two points where the orbit of a planet intersects the ecliptic.

Plate CCIV. fig. 4. n° 1.

Such are the two points C and D; of which the node C, where the planet ascends northward above the plane of the ecliptic, is called the *ascending node*, or the *dragon's head*, and is marked thus ☊. The other node D, where the planet descends to the south, is called the *descending node*, or the *dragon's tail*, marked thus ☋.

The line CD, wherein the two circles C E D F and C G D H intersect, is called the *line of nodes*. It apprears from observation, that the line of the nodes of all the planets, constantly changes its place, and shifts its situation from east to west, contrary to the order of the signs; and that the line of the moon's nodes, by a retrograde motion, finishes it circulation in the compass of 19 years; after which time, either of the nodes having receded from any point of the ecliptic, returns to the same again; and when the moon is in the node, she is also seen in the ecliptic. If the line of nodes were immoveable, that is, if it had no other motion than that whereby it is carried round the sun, it would always look to the same point of the ecliptic, or would keep parallel to itself, as the axis of the earth does.

From what hath been said, it is evident, that the moon can never be observed precisely in the ecliptic, but twice in every period; that is, when she enters the nodes. When she is at her greatest distance from the nodes; viz. in the points E, F, she is said to be in her limits.

The moon must be in or near one of the nodes, when there is an eclipse of the sun or moon.

To make the foregoing account of the motion of moon's nodes still clearer, let the plane of n° 2. *ibid.* represent that of the ecliptic, S the sun, T the centre of the earth, L the moon in her orbit D N *d n*. N *n* is the line of the nodes passing between the quadrature Q, and the moon's place L, in her last quarter. Let now L P, or any part L S, represent the excess of the sun's action at T; and this being resolved into the force L R, perpendicular to the plane of the moon's orbit, and P R parallel to it, it is the former only that has any effect to alter the position of the orbit, and in this it is wholly exerted. Its effect is twofold: 1. It diminishes its inclination by a motion which we may conceive as performed round the diameter D *d*, to which L T is perpendicular. 2. Being compounded with the moon's tangential motion at L, it gives it an intermediate direction L *t*, through which, and the centre, a plane being drawn, must meet the ecliptic nearer the conjunction C than before.

NODUS, or node, in dialling, a certain point or pole in the gnomon of a dial, by the shadow or light whereof either the hour of the day in dials without furniture, or the parallels of the sun's declination, and his place in the ecliptic, &c. in dials with furniture, are shewn. See DIALLING.

NOEOMAGUS LEXUVIORUM, (Ptol.); thought to be the *Civitas Lexoviorum* of the lower age. Now *Lisieux*, a city in Normandy.—Another of the *Tricastini*; a town of Gallia Narbonensis; thought to be *S. Pol de Trois Châteaux*, six miles to the west of Nyons in Dauphiné.

NOETIANS, in church-history, Christian heretics in the third century, followers of Noetius, a philosopher of Ephesus, who pretended that he was another Moses sent by God, and that his brother was a new Aaron. His heresy consisted in affirming that there was but one person in the Godhead; and that the Word and the Holy Spirit were but external denominations given to God in consequence of different operations: that as Creator, he is called *Father*; as Incarnate, *Son*; and as descending on the apostles, *Holy Ghost*.

NOLA, a very ancient city, formerly populous and strong, situate in a plain to the north-east of Vesuvius in Campania, said to be built by the Chalcidians, (Justin, Silius Italicus); according to others, by the Tuscans. At this place Hannibal met with the first check by Marcellus. Vespasian added the appellation *Augusta Colonia*, (Frontinus). At this place, or in its neighbourhood, Augustus is said to have expired. At this day retaining its old name, but fallen short of its ancient splendour. A town of the kingdom of Naples. E. Long. 15. N. Lat. 41. 5.

NOLLE PROSEQUI, is where a plaintiff in an action does not declare in a reasonable time; in which case it is usual for the defendant's attorney to enter a rule for the plaintiff to declare, after which a *non pros* may be entered. A *nolle prosequi* is esteemed a voluntary confession, that the plaintiff has no cause of action: and therefore if a plaintiff enter his *nolle prosequi*, he shall be amerced; and if an informer cause the same to be entered, the defendant shall have costs.

NOMADES,

NOMADES, a name given, in antiquity, to feveral nations or people whofe whole occupation was to feed and tend their flocks; and who had no fixed place of abode, but were conftantly fhifting, according to the conveniencies of pafturage.—The word comes from the Greek νεμω, *pafco*, "I feed."

The moft celebrated among the Nomades were thofe of Africa, who inhabited between Africa, properly fo called, to the eaft, and Mauritania to the weft. They are alfo called *Numidæ*, or *Numidians*.—Salluft fays, they were a colony of Perfians brought into Africa with Hercules.

The Nomades of Afia inhabited the coafts of the Cafpian Sea.—The Nomades of Scythia were the inhabitants of Little Tartary; who ftill retain the ancient manner of living.

NOMARCHA, in antiquity, the governor or commander of a nome, or nomos.—Egypt was anciently divided into feveral regions or quarters, called *nomes*, from the Greek νομος, taken in the fenfe of a divifion; and the officer who had the adminiftration of each *nome*, or *nomos*, from the king, was called *monarcha*, from νομος and αρχη, "command."

NOMBRE-DE-DIOS, a town of Mexico, in the province of Darien, a little to the eaftward of Porto-Bello. It was formerly a famous place; but it is now abandoned, on account of its unhealthy fituation. W. Long. 78. 35. N. Lat. 9. 43.

NOMBRIL POINT, in heraldry, is the next below the fefs point, or the very centre of the efcutcheon.

Suppofing the efcutcheon divided into two equal parts below the fefs, the firft of thefe divifions is the nombril, and the lower the bafe.

NOME, or NAME, in algebra, denotes any quantity with a fign prefixed or added to it, whereby it is connected with fome other quantity, upon which the whole becomes a binomial, trinomial, or the like. See ALGEBRA.

NOMENCLATOR, in Roman antiquity, was ufually a flave who attended upon perfons that ftood candidates for offices, and prompted or fuggefted to them the names of all the citizens they met, that they might court them and call them by their names, which among that people was the higheft piece of civility.

NOMENCLATORS, among the botanical authors, are thofe who have employed their labours about fettling and adjufting the right names, fynonyms, and etymologies of names, in regard to the whole vegetable world.

NOMENCLATURE, NOMENCLATURA, a catalogue of feveral of the more ufual words in any language, with their fignifications, compiled in order to facilitate the ufe of fuch words to thofe who are to learn the tongue: fuch are our Latin, Greek, French, &c. Nomenclatures.

NOMENEY, a town of Germany, in the duchy of Lorrain, fituated on the river Seille, 15 miles north of Nancy.

NOMINALS, or NOMINALISTS, a fect of fchool-philofophers, the difciples and followers of Occam, or Ocham, an Englifh cordelier, in the 14th century. They were great dealers in words, whence they were vulgarly denominated *Word-fellers*; but had the denomination of *Nominalifts*, becaufe that, in oppofition to the *Realifts*, they maintained, that words, and not things, were the object of dialectics.

NOMINATIVE, in grammar, the firft CASE of NOUNS which are declinable.

The fimple pofition, or laying down of a noun, or name, is called the *nominative cafe*; yet it is not fo properly a cafe, as the matter or ground, whence the other cafes are to be formed, by the feveral changes and inflections given to this firft termination. Its chief ufe is to be placed in difcourfe before all verbs, as the fubject of the propofition or affirmation.

NONAGE, in law, generally fignifies all the time a perfon continues under the age of 21; but, in a fpecial fenfe, it is all the time that a perfon is under the age of 14.

NON-CAPE, a promontory on the weft coaft of Africa, oppofite to the Canary iflands. W. Long. 12. 0. N. Lat. 44. 28.

NONCONFORMISTS, thofe who refufe to join the eftablifhed worfhip.

Nonconformifts, in England, are of two forts. Firft, fuch as abfent themfelves from divine worfhip in the eftablifhed church through total irreligion, and attend the fervice of no other perfuafion. Thefe, by the ftat. 1 Eliz. c. 2. 23 Eliz. c. 1. and 3 Jac. I. c. 4. forfeit one fhilling to the poor every Lord's-day they fo abfent themfelves, and 20l. to the king if they continue fuch default for a month together. And if they keep any inmate thus irreligioufly difpofed in their houfes, they forfeit 10l. *per* month. *Blackft. Comment.*

The fecond fpecies of nonconformifts are thofe who offend through a miftaken or perverfe zeal. Such were efteemed, by the Englifh laws enacted fince the time of the Reformation, to be Papifts and Proteftant diffenters: both of which were fuppofed to be equally fchifmatics, in not communicating with the national church; with this difference, that the Papifts divided from it upon material, though erroneous, reafons; but many of the diffenters upon matters of indifference, or, in other words, upon no reafon at all. "Yet certainly (fays Sir William Blackftone) our anceftors were miftaken in their plans of compulfion and intolerance. The fin of fchifm, as fuch, is by no means the object of temporal coercion and punifhment. If, through weaknefs of intellect, through mifdirected piety, through perverfenefs and acerbity of temper, or (which is often the cafe) through a profpect of fecular advantage in herding with a party, men quarrel with the ecclefiaftical eftablifhment, the civil magiftrate has nothing to do with it; unlefs their tenets and practice are fuch as threaten ruin or difturbance to the ftate. He is bound indeed to protect the eftablifhed church: and if this can be better effected by admitting none but its genuine members to offices of truft and emolument, he is certainly at liberty fo to do; the difpofal of offices being matter of favour and difcretion. But, this point being once fecured, all perfecution for diverfity of opinions, however ridiculous or abfurd they may be, is contrary to every principle of found policy and civil freedom. The names and fubordination of the clergy, the pofture of devotion, the materials and colour of the minifter's garment, the joining in a known or unknown form of prayer, and other matters of the fame kind, muft be left to the option of every man's private judgment.

Noncon-formifts.

Blackft. Comment.

" With regard therefore to *Proteftant diffenters,* although the experience of their turbulent difpofition in former times occafioned feveral difabilities and reftrictions (which I fhall not undertake to juftify) to be laid upon them by abundance of ftatutes; yet at length the legiflature, with a true fpirit of magnanimity, extended that indulgence to thefe fectaries, which they themfelves, when in power, had held to be countenancing fchifm, and denied to the church of England. The penalties are conditionally fufpended by the ftatute 1 W. & M. ft. 1. c. 18. " for exempting their Majefties Proteftant fubjects, diffenting from the church of England, from the penalties of certain laws," commonly called the *toleration act;* which declares, that neither the laws above-mentioned, nor the ftatutes 1 Eliz. c. 2. § 14. 3 Jac. I. c. 4. & 5. nor any other penal laws made againft Popifh recufants (except the teft-acts) fhall extend to any diffenters, other than Papifts and fuch as deny the Trinity: provided, 1. That they take the oaths of allegiance and fupremacy, (or make a fimilar affirmation, being Quakers), and fubfcribe the declaration againft Popery. 2. That they repair to fome congregation certified to, and regiftered in the court of the bifhop or archdeacon, or at the county-feffions. 3. That the doors of fuch meeting-houfe fhall be unlocked, unbarred, and unbolted; in default of which, the perfons meeting there are ftill liable to all the penalties of the former acts. Diffenting teachers, in order to be exempted from the penalties of the ftatutes 13 & 14 Car. II. c. 4. 17 Car. II. c. 2. and 22 Car. II. c. 1. are alfo to fubfcribe the articles of religion mentioned in the ftatute 13 Eliz. c. 12. (viz. thofe which only concern the confeffion of the true Chriftian faith, and the doctrine of the facraments), with an exprefs exception of thofe relating to the government and powers of the church, and to infant-baptifm. And by ftatute 10 Ann. c. 2. this toleration is ratified and confirmed; and it is declared, that the faid act fhall at all times be inviolably obferved for the exempting fuch Proteftant diffenters as are thereby intended, from the pains and penalties therein mentioned. Thus, though the offcence of nonconformity is by no means univerfally abrogated, it is fufpended, and ceafes to exift with regard to thefe Proteftant diffenters, during their compliance with the conditions impofed by the act of toleration: and, under thefe conditions, all perfons, who will approve themfelves no Papifts or oppugners of the Trinity, are left at full liberty to act as their confciences fhall direct them in the matter of religious worfhip. And if any perfon fhall wilfully, malicioufly, or contemptuoufly difturb any congregation, affembled in any church or permitted meeting-houfe, or fhall mifufe any preacher or teacher there, he fhall (by virtue of the fame ftatute) be bound over to the feffions of the peace, and forfeit 20 l. But by ftatute 5 Geo. I. c. 4. no mayor or principal magiftrate muft appear at any diffenting meeting with the enfigns of his office, on pain of difability to hold that or any other office: the legiflature judging it a matter of propriety, that a mode of worfhip, fet up in oppofition to the national, when allowed to be exercifed in peace, fhould be exercifed alfo with decency, gratitude, and humility. Neither doth the act of toleration extend to enervate thofe claufes of the ftatutes 14 & 13 Car. II. c. 4. & 17 Car. II. c. 2. which prohibit (upon pain of fine and imprifonment) all perfons from teaching fchool, unlefs they be licenfed by the ordinary, and fubfcribe a declaration of conformity to the liturgy of the church, and reverently frequent divine fervice *eftablifhed* by the laws of this kingdom.

Noncon-formifts.

" As to *Papifts,* what has been faid of the Proteftant diffenters would hold equally ftrong for a general toleration of them; provided their feparation was founded only upon difference of opinion in religion, and their principles did not alfo extend to a fubverfion of the civil government. If once they could be brought to renounce the fupremacy of the Pope, they might quietly enjoy their feven facraments; their purgatory, and auricular confeffion; their worfhip of relics and images; nay, even their tranfubftantiation. But while they acknowledge a foreign power, fuperior to the fovereignty of the kingdom, they cannot complain if the laws of that kingdom will not treat them upon the footing of good fubjects.

" The following are the laws that have been enacted againft the Papifts; who may be divided into three claffes, perfons profeffing Popery, Popifh recufants convict, and Popifh priefts. 1. Perfons profeffing the Popifh religion, befides the former penalties for not frequenting their parifh-church, are difabled from taking any lands either by defcent or purchafe, after 18 years of age, until they renounce their errors; they muft at the age of 21 regifter their eftates before acquired, and all future conveyances and wills relating to them; they are incapable of prefenting to any advowfon, or granting to any other perfon any avoidance of the fame; they may not keep or teach any fchool under pain of perpetual imprifonment; and, if they willingly fay or hear mafs, they forfeit the one 200, the other 100 merks, and each fhall fuffer a year's imprifonment. Thus much for perfons who, from the misfortune of family-prejudices, or otherwife, have conceived an unhappy attachment to the Romifh church from their infancy, and publicly profefs its errors. But if any evil induftry is ufed to rivet thefe errors upon them; if any perfon fends another abroad to be educated in the Popifh religion, or to refide in any religious houfe abroad for that purpofe, or contributes to their maintenance when there; both the fender, the fent, and the contributor, are difabled to fue in law or equity, to be executor or adminiftrator to any perfon, to take any legacy or deed of gift, and to bear any office in the realm; and fhall forfeit all their goods and chattels, and likewife all their real eftate for life. And where thefe errors are alfo aggravated by apoftacy or perverfion; where a perfon is reconciled to the fee of Rome, or procures others to be reconciled, the offence amounts to high-treafon. 2. Popifh recufants, convicted in a court of law of not attending the fervice of the church of England, are fubject to the following difabilities, penalties, and forfeitures, over and above thofe beforementioned. They are confidered as perfons excommunicated; they can hold no office or employment; they muft not keep arms in their houfes, but the fame may be feized by the juftices of the peace; they may not come within 10 miles of London, on pain of 100 l.; they can bring no action at law or fuit in equity; they are not permitted to travel above five miles from home, unlefs by licenfe,

Nonconformiſts.

cenſe, upon pain of forfeiting all their goods; and they may not come to court under pain of 100 l. No marriage or burial of ſuch recuſant, or baptiſm of his child, ſhall be had otherwiſe than by the miniſters of the church of England, under other ſevere penalties. A married woman, when recuſant, ſhall forfeit two thirds of her dower or jointure, may not be executrix or adminiſtratrix to her huſband, nor have any part of his goods; and during the coverture may be kept in priſon, unleſs her huſband redeems her at the rate of 10 l. a month, or the third part of all his lands. And laſtly, as a feme-covert recuſant may be impriſoned, ſo all others muſt, within three months after conviction, either ſubmit and renounce their errors, or, if required ſo to do by four juſtices, muſt abjure and renounce the realm: and if they do not depart, or if they return without the king's licence, they ſhall be guilty of felony, and ſuffer death as felons without benefit of clergy. There is alſo an inferior ſpecies of recuſancy, (refuſing to make the declaration againſt Popery enjoined by ſtatute 30 Car. II. ſt. 2. when tendered by the proper magiſtrate); which, if the party reſides within ten miles of London, makes him an abſolute recuſant convict; or, if at a greater diſtance, ſuſpends him from having any ſeat in parliament, keeping arms in his houſe, or any horſe above the value of 5 l. 3. Popiſh prieſts are in a ſtill more dangerous condition. By ſtatute 11 & 12 W. III. c. 4. Popiſh prieſts, or biſhops, celebrating maſs or exerciſing any part of their functions in England, except in the houſes of ambaſſadors, are liable to perpetual impriſonment. And by the ſtatute 27 Eliz. c. 2. any Popiſh prieſt, born in the dominions of the crown of England, who ſhall come over hither from beyond ſea, (unleſs driven by ſtreſs of weather and tarrying only a reaſonable time), or ſhall be in England three days without conforming and taking the oaths, is guilty of high treaſon: and all perſons harbouring him are guilty of felony without the benefit of clergy.

This is a ſhort ſummary of the laws againſt the Papiſts; of which the preſident Monteſquieu obſerves, that they are ſo rigorous, though not profeſſedly of the ſanguinary kind, that they do all the hurt that can poſſibly be done in cold blood. But in anſwer to this it may be obſerved, (what foreigners who only judge from our ſtatute-book are not fully apprized of) that theſe laws are ſeldom exerted to their utmoſt rigour: and indeed, if they were, it would be very difficult to excuſe them. For they are rather to be accounted for from their hiſtory, and the urgency of the times which produced them, than to be approved (upon a cool review) as a ſtanding ſyſtem of law. The reſtleſs machinations of the Jeſuits during the reign of Elizabeth, the turbulence and uneaſineſs of the Papiſts under the new religious eſtabliſhment, and the boldneſs of their hopes and wiſhes for the ſucceſſion of the queen of Scots, obliged the parliament to counteract ſo dangerous a ſpirit by laws of a great, and then perhaps neceſſary, ſeverity. The powder-treaſon, in the ſucceeding reign, ſtruck a panic into James I. which operated in different ways: it occaſioned the enacting of new laws againſt the Papiſts; but deterred him from putting them in execution. The intrigues of queen Henrietta in the reign of Charles I. the proſpect of a Popiſh ſucceſſor in that of Char. II. the aſſaſſination-plot in the reign of king William, and the avowed claim of a Popiſh pretender to the crown in ſubſequent reigns, will account for the extenſion of theſe penalties at thoſe ſeveral periods of our hiſtory." But now that all juſt fears of a pretender may be ſaid to have vaniſhed; and the power and influence of the pope has become feeble, ridiculous, and deſpicable, not only in Britain, but in almoſt every kingdom of Europe; and as in fact the Britiſh Catholics ſolemnly diſclaim the dangerous principles aſcribed to them †; the Britiſh legiſlature, giving way to that liberality of ſentiment becoming Proteſtants, have lately repealed the moſt rigorous of the above edicts, *viz.* The puniſhment of Popiſh prieſts or Jeſuits who ſhould be found to teach or officiate in the ſervices of that church; which acts were felony in foreigners, and high treaſon in the natives of this kingdom:—The forfeitures of Popiſh heirs, who had received their education abroad; and whoſe eſtates went to the next Proteſtant heir:—The power given to the ſon, or other relation, being a Proteſtant, to take poſſeſſion of the father's or other relation's eſtate, during the life of the real proprietor:—And the debarring Papiſts from the power of acquiring any legal property by purchaſe.—In propoſing the repeal of theſe penalties, it was obſerved, That, beſides that ſome of them had now ceaſed to be neceſſary, others were at all times a diſgrace to humanity. The impriſonment of a Popiſh prieſt for life, only for officiating in the ſervices of his religion, was horrible in its nature: And although the mildneſs of government had hitherto ſoftened the rigour of the law in the practice, it was to be remembered that the Roman Catholic prieſts conſtantly lay at the mercy of the baſeſt and moſt abandoned of mankind—of common informers; for on the evidence of any of theſe wretches, the magiſterial and judicial powers were of neceſſity bound to enforce all the ſhameful penalties of the act. Others of theſe penalties held out the moſt powerful temptations for the commiſſion of acts of depravity, at the very thought of which our nature recoils with horror: They ſeemed calculated to looſen all the bands of ſociety; to diſſolve all civil, moral, and religious obligations and duties, to poiſon the ſources of domeſtic felicity, and to annihilate every principle of honour. The encouragement given to children to lay their hands upon the eſtates of their parents, and the reſtriction which debars any man from the honeſt acquiſition of property, need only to be mentioned to excite indignation in an enlightened age.

† See their loyal Addreſs to the throne, May 1. 1778, as inſerted in the Magazines or Annual Regiſter for that year.

In order the better to ſecure the Engliſh eſtabliſhed church againſt perils from non-conformiſts of all denominations, infidels, Turks, Jews, heretics, Papiſts, and ſectaries, there are, however, two bulwarks erected; called the *corporation* and *teſt acts*: By the former of which, no perſon can be legally elected to any office relating to the government of any city or corporation, unleſs, within a twelvemonth before, he has received the ſacrament of the Lord's ſupper according to the rights of the church of England; and he is alſo enjoined to take the oaths of allegiance and ſupremacy at the ſame time that he takes the oath of office: or, in default of either of theſe requiſites, ſuch election ſhall be void. The other, called the *teſt act*, directs all officers civil and military to take the oaths and make the declaration againſt tranſubſtantiation, in any of

of the king's courts at Weftminfter, or at the quarter-feffions, within fix calendar months after their admiffion; and alfo within the fame time to receive the facrament of the Lord's fupper, according to the ufage of the church of England, in fome public church immediately after divine fervice and fermon, and to deliver into court a certificate thereof figned by the minifter and church-warden, and alfo to prove the fame by two credible witneffes; upon forfeiture of 500l. and difability to hold the faid office. And of much the fame nature with thefe is the ftatute 7 Jac. I. c. 2. which permits no perfons to be naturalifed or reftored in blood, but fuch as undergo a like teft: which teft having been removed in 1753, in favour of the Jews, was the next feffion of parliament reftored again with fome precipitation.

NON-*Naturals*, in medicine, fo called, becaufe by their abufe they become the caufes of difeafes.

Phyficians have divided the non-naturals into fix claffes, viz. the air, meats and drinks, fleep and watching, motion and reft, the paffions of the mind, the retentions and excretions. See MEDICINE, n° 147, &c.

NON *Obftante*, *(notwithftanding,)* a claufe frequent in ftatutes and letters-patent, importing a licence from the king to do a thing, which at common law might be lawfully done, but being reftrained by act of parliament cannot be done without fuch licence.

NON *Pros*. See NOLLE *Profequi*.

NON-*Suit*, fignifies the dropping of a fuit or action, or a renouncing thereof by the plaintiff or defendant; which happens moft commonly upon the difcovery of fome error in the plaintiff's proceedings when the caufe is fo far proceeded in, that the jury is ready at the bar to deliver in their verdict.

NONES, (NONÆ,) in the Roman kalendar, the fifth day of the months January, February, April, June, Auguft, September, November, and December; and the feventh of March, July, and October. March, May, July, and October, had fix days in their nones; becaufe thefe alone, in the ancient conftitution of the year by Numa, had 31 days a-piece, the reft having only 29, and February 30: but when Cæfar reformed the year, and made other months contain 31 days, he did not allot them fix days of nones.

NONIUS (Peter), in Spanifh *Nunes*, a learned Portuguefe, and one of the ableft mathematicians of the 16th century, was born at Alcacer. He was preceptor to Don Henry, king Emmanuel's fon, and taught the mathematics in the univerfity of Coimbra. He publifhed the following works, by which he gained great reputation: 1. *De arte navigandi*. 2. *Annotationes in theorias planetarum Purbachii*; which are greatly efteemed. 3. A treatife *De crepufculis*. 4. A treatife on algebra. It is obferved in Furetiere's dictionary, that Peter Nonius, in 1530, firft invented the angles of 45 degrees made in every meridian, and that he called them *rhumbs* in his language, and calculated them by fpherical triangles. Nonius died in 1577, aged 80.

NONIUS (Marcellus), a grammarian and Peripatetic philofopher, born at Tivoli, wrote a treatife, intitled *De proprietate fermonum*. This author is only valuable for his giving fragments of ancient authors that are nowhere elfe to be found. The above treatife was printed at Paris in 1614, with notes.

NONNIUS, or NONIUS (Lewis), a learned phyfician of Antwerp in the 17th century, wrote feveral works which are efteemed; the principal of which are, 1. An excellent treatife intitled *Ichthyophagia, five de Pifcium efu*. 2. *Hifpania*; which is of great ufe in underftanding the ancient geography of Spain. 3. A commentary on the medals of Greece, and thofe of Julius Cæfar, Auguftus, and Tiberius, in folio: it contains Goltzius's two works on the fame fubject. 4. A commentary on Goltzius's account of Greece, the iflands, &c. 5. Poems, &c.

NONNUS, a Greek poet of the 5th century, and native of Panopilis in Egypt, was the author of an heroic poem in 48 books, intitled *Dionyfiacorum*, and a paraphrafe in verfe of St John's Gofpel, which may ferve as a commentary upon it.

NORDEN (Frederic Lewis), an ingenious traveller and naval officer in the Danifh fervice, was born at Gluckftadt in Holftein in the year 1708. He was well fkilled in mathematics, fhip-building, and efpecially in architecture; and in 1732 obtained a penfion to enable him to travel for the purpofe of ftudying the conftruction of fhips, particularly the galleys and other rowing veffels ufed in the Mediterranean. He fpent near three years in Italy, and Chriftian VI. being defirous of obtaining a circumftantial account of Egypt, Mr Norden at Florence received an order to extend his travels to that country. How he acquitted himfelf in this commiffion, appears from his Travels into Egypt and Nubia, printed at Copenhagen in folio, 1756; and which were foon after tranflated into Englifh by Dr Peter Templeman. In the war between England and Spain, Mr Norden, then a captain in the Danifh navy, attended count Ulric Adolphus, a fea-captain, to England; and they went out volunteers under Sir John Norris, and afterwards under Sir Chaloner Ogle. During his ftay in London, Mr Norden was made a fellow of the royal fociety, and gave the public drawings of fome ruins and coloffal ftatues at Thebes in Egypt; with an account of the fame, in a letter to the royal fociety, 1741. His health at this time was declining; and taking a tour to France, he died at Paris in 1742.

NORFOLK, a county of England, fo called from its northern fituation in refpect of Suffolk, is bounded on the eaft and north by the German ocean; on the fouth by Suffolk, from which it is parted by the rivers Waveney, and the Leffer Oufe; and on the weft it is feparated from Cambridgefhire by the Greater Oufe, and from a fmall part of Lincolnfhire by the wafhes. According to Templeman, it extends in length 57 miles, in breadth 35, and 140 in circumference. It contains an area of 1426 fquare miles, one city, 32 market-towns, 711 villages, according to the book of rates; though fome make them 1500, and 236000 inhabitants, as fome have it, and 283000, according to others. It is divided into 31 hundreds, 164 vicarages, and 660 parifhes.

The air differs in different parts of the county, according to the foil, which in fome parts is marfhy, efpecially on the fea-coaft, and there the air is foggy and unwholefome: in others it is clayey and chalky, poor, lean, and fandy; and there the air is good. The county is almoft all champaign, except in fome places, where

where rife gentle hills. The marfh-lands yield rich pafture for cattle; the clay-grounds peafe, rye, and barley; and the fandy-heaths feed vaft flocks of large fheep, of which fome villages are faid to keep 4000 or 5000. Thefe heaths abound alfo in rabbits of a filver-grey colour. Walfingham is noted for producing the beft faffron. Great quantities of mackarel and herring are caught upon the coafts of this county, the former in the fpring, and the latter in September; efpecially at Yarmouth, where they are cured in a particular manner, and to great perfection. Wood and honey are alfo very plentiful in this fhire; and on the coafts jet and ambergreafe are fometimes found. The inhabitants are generally ftrong and active, fagacious and acute. That they are fo robuft, is the more to be wondered at, becaufe the common people live much on puddings, *Norfolk dumplings*. They are for the moft part in eafy circumftances, and were formerly very quarrelfome and litigious. In confequence of this difpofition, lawyers fwarmed among them to fuch a degree, that a ftatute was made fo early as the reign of Henry VI. to reftrain their number. The manufactures of the county, which is exceedingly populous, are chiefly woollen and worfted ftuffs, and ftockings, for which they are well fupplied with wool from the vaft flocks of fheep bred in it. It gives title of duke to the elder branch of the family of Howard, lies in the diocefe of Norwich, and fends twelve members to parliament, viz. two knights for the fhire, two citizens for Norwich, and two burgeffes for each of the boroughs of Lynn Regis, Great Yarmouth, Thetford, and Caftle-rifing.

The county is well watered, and fupplied with fifh by the rivers Yare, Thyrn, Waveney, the Greater and Leffer Oufe, and the Bure, befides rivulets. The Bure abounds in excellent perch, and the Yare has a fifh peculiar to it called the *ruffe*. The latter rifes about the middle of the county; and after being joined by the Waveney and Bure, falls into the fea at Yarmouth. At the equinoxes, efpecially the autumnal, the Oufe is fubject to great inundations, heing forced back by the fea that enters it with great fury.

Norfolk, a county of Virginia contiguous to North Carolina.

NORMANDY, a province of France, bounded on the north by the Englifh channel; on the eaft by Picardy and the ifle of France; on the fouth by Perche and Maine, and one part of Bretague; and on the weft by the ocean. It is about 150 miles in length, 80 in breadth, and 600 in circumference. It is one of the moft fertile, and brings in the largeft revenue of the kingdom. It abounds in all things except wine, but they fupply that defect by cyder and perry. There are vaft meadows, fat paftures, and the fea yields plenty of fifh. It contains iron, copper, and a great number of rivers and harbours. It carries on a great trade, is very populous, and comprehends a vaft number of towns and villages. It is divided into the Upper and Lower; the Upper borders upon Picardy, and the Lower upon Bretagne. The inhabitants are ingenious, and capable of underftanding arts and fciences, but they are very fond of law. The Normans, a people of Denmark and Norway, having entered France under Rollo, Charles the Simple ceded this country to them in 912, which from that time was called *Normandy*. Rollo was the firft duke, and held it as a fief of the crown of France, and feveral of his fucceffors after him, till William, the feventh duke, conquered England in 1066: from which time it became a province of England, till it was loft in the reign of king John, and re-united to the crown of France; but the Englifh ftill keep the iflands on the coafts of Normandy.

NORTH (Dudley, lord), the third baron of that accomplifhed family, was one of the fineft gentlemen in the court of king James; but, in fupporting that character, diffipated and gamed away the greateft part of his fortune. In 1645, he appears to have acted with the parliament; and was nominated by them to be adminiftrator of the admiralty, in conjunction with the great earls of Northumberland, Effex, Warwick, and others. He lived to the age of 85, the latter part of which he paffed in retirement; and wrote a fmall folio of mifcellanies, in profe and verfe, under this title, A Foreft promifcuous of feveral Seafons Productions, in four parts, 1659.

North (Dudley, lord) fon of the former, was made knight of the bath in 1616, at the creation of Charles prince of Wales; and fat in many parliaments, till fecluded by the prevailing party in that which condemned the king. From that period lord North lived privately in the country, and towards the end of his life entertained himfelf with books, and, as his numerous iffue required, with œconomy, on which he wrote a little tract, called *Obfervations and advices œconomical*, 12mo. His other works are, Paffages relating to the long parliament; The hiftory of the life of the lord Edward North, the firft baron of the family, addreffed to his eldeft fon; and a volume of effays.

North (Francis lord Guilford, lord-keeper of the great-feal in the reigns of Charles II. and James II.) was a third fon of the fecond Dudley lord North, baron of Kertling; and ftudied at St John's college in Cambridge, from whence he removed to Middle Temple. He acquired French, Italian, Spanifh, and Dutch; and became not only a good lawyer, but was well verfed in hiftory, mathematics, philofophy, and mufic. He was afterwards made the king's folicitor-general, and was chofen to reprefent the borough of Lynn in parliament. He fucceeded Sir Heneage Finch in the poft of attorney-general; and lord chief-juftice Vaughan, in the place of lord chief-juftice of the common-pleas. He was afterwards made keeper of the great-feal; and in 1683 was created a baron, by the title of *lord Guilford*. He died at his houfe at Wroxton in 1685. He wrote a philofophical effay on mufic; a paper on the gravitation of fluids, confidered in the bladders of fifhes, printed in Lowthorp's abridgment of the Philofophical Tranfactions; and fome other pieces.

North, one of the four cardinal points. See Pole.

North-*Cape*, the moft northerly promontory in Europe, on the coaft of Norway. E. Long. 21. 0. N. Lat. 78. 0.

North-*Foreland*, a cape or promontory of Kent, in the ifle of Thanet, four miles eaft of Margate. Between this and the South-Foreland are the Downs, through which all fhips pafs that are bound to or from the

North-Northamptonshire. the weft. E. Long. 1. 25. N. Lat. 51. 25.

NORTH-*Weft Paffage*, a paffage to the Pacific Ocean through Hudfon's Bay or Davis's Straits, and which hath been frequently attempted without fuccefs; notwithftanding which, many people are ftill of opinion that it is practicable.

NORTH-*Eaft Paffage*, a paffage to the Eaft Indies along the northern coafts of Afia, which, like the former, hath frequently been attempted, but hitherto without fuccefs. Concerning thefe paffages an opinion hath lately been revived by the hon. Daines Barrington, namely, that they ought to be attempted by the pole itfelf; and he hath no doubt of the poffibility of accomplifhing them by that means. See *North* POLE.

NORTHAMPTON, a town of England, capital of a county of the fame name, fituated in W. Long. 0. 55. N. Lat. 52. 15. According to Camden, it was formerly called *North-afandon*, from its fituation to the north of the river Nen, called anciently *Aufona*, by which and another leffer river it is almoft enclofed. Dr Gibfon fays, that the ancient Saxon annals called both it and Southampton fimply *Hamton;* and afterwards, to diftinguifh them, called the one, from its fituation, *Southamton*, and the other *Northamton;* but never *North-afandon*, Though it does not appear to be a place of very great antiquity, yet here was a caftle, and a church dedicated to St Andrew, built by Simon de Sancto Licio, commonly called *Senlez*, the firft earl of Northampton of that name. It is faid to have been burnt down during the Danifh depredations; but in the reign of St Edward it appears to have been a confiderable place. It was befieged by the barons in their war with king John; at which time that military work called *Hunfhill*, is fuppofed to have been raifed. In the time of Henry III. it fided with the barons, when it was befieged and taken by the king. Here the bloody battle was fought in which Henry VI. was taken prifoner; and feveral parliaments have been held in this town. It was entirely confumed by a moft dreadful fire in 1675; yet, by the help of liberal contributions from all parts of the kingdom, it hath fo recovered itfelf, that it is now one of the neateft and beft-built towns of the kingdom. Among the public buildings, which are all lofty, the moft remarkable are the church called *All-hallows*, the feffions and affize houfe, and the George inn, which belongs to the poor of the town. There was formerly a nunnery in the neighbouring meadows. A county-hofpital or infirmary has been lately built here, after the manner of thofe of Bath, London, Briftol, &c. It has a confiderable manufacture of fhoes and ftockings; and its fairs are noted for horfes both for draught and faddle; befides, it is a great thoroughfare for the north and weft roads. It gives title of *earl* to the family of Compton.

NORTHAMPTONSHIRE, a county of England, is fituated in the very heart of the kingdom: bounded on the eaft by the counties of Bedford and Huntingdon; on the fouth by thofe of Buckingham and Oxford; on the weft by Warwickfhire; and on the north by the counties of Leicefter, Rutland, and Lincoln, which are feparated from it by the Leffer Avon, and the Welland. Its greateft length is about 50 miles, its greateft breadth about 20, and its circumference about 130. It contains 33 parifhes; in which are one city, 11 market-towns, and 150,000 inhabitants. Nine members are returned to parliament for this county, viz. two knights for the fhire, two for the city of Peterborough, two for each of the towns of Northampton and Brockley, and one for Higham Ferrers. It lies in the Mid-land circuit, and the diocefe of Peterborough. As this county is dry, well cultivated, free from marfhes, except the fens about Peterborough, in the centre of the kingdom, and of courfe at a diftance from the fea, it enjoys a very pure and wholefome air. In confequence of this it is very populous, and fo full of towns and churches, that 30 fpires or fteeples may be feen in many places at one view; and even in the fens, the inhabitants feem to enjoy a good ftate of health, and to be little affected by the water which frequently overflows their grounds, efpecially in winter, but is never fuffered to remain long upon it. Its foil is exceeding fertile both in corn and pafturage; but it labours under a fcarcity of fuel, as it doth not produce much wood, and, by lying at a diftance from the fea, cannot be eafily fupplied with coal. Its commodities, befides corn, are fheep, wool, black cattle, and faltpetre; and its manufactures are ferges, tammies, fhalloons, boots, and fhoes. Befides many leffer brooks and ftreams, it is well watered by the rivers Nen, Welland, Oufe, and Leam; the three firft of which are large, and for the moft part navigable.

Northumberland.

NORTHUMBERLAND, the moft northerly county of England, and formerly a diftinct kingdom, is bounded on the north and weft by the river Tweed, which divides it from Scotland, the Cheviot-hills, and part of Cumberland; wafhed on the eaft by the German Ocean; and feparated from Durham on the fouth by the rivers Tyne and Derwent. This county, which gives the title of *duke* to a nobleman who married the daughter of Algernoon duke of Somerfet, whofe mother was heirefs of the Piercy family, extends about 50 miles in length from north to fouth, and above 40 from eaft to weft; and is remarkably populous, containing 11 market-towns, 280 villages, and 46 parifhes. The face of the country, efpecially towards the weft, is roughened with huge mountains, the moft remarkable of which are the Cheviot-hills, and the high ridge called *Ridefdale;* but the lands are level towards the fea-fide and the borders of Durham. The climate, like that of every other mountainous country in the neighbourhood of the fea, is moift and difagreeable: the air, however, is pure and healthy, as being well ventilated by breezes and ftrong gales of wind; and in winter mitigated by the warm vapours from the two feas, the Irifh and the German Ocean, between which it is fituated. The foil varies in different parts of the county. Among the hills it is barren; though it affords good pafture for fheep, which cover thofe mountains. The low country, when properly cultivated, produces plenty of wheat, and all forts of grain; and great part of it is laid out in meadow-lands and rich enclofures. Northumberland is well watered with many rivers, rivulets, and fountains: its greateft rivers are the Tweed and the Tyne. The Tyne is compofed of two ftreams called *South* and *North Tyne:* the firft rifes on the verge of Cumberland, near Alfton-moor; enters Northumberland,

land, running north to Haltwefel; then bends eafterly, and receiving the two fmall rivers Eaft and Weft Alon, unites above Hexham with the other branch, taking its rife at a mountain called *Fane-head* in the weftern part of the county, thence called *Tine-dale;* is fwelled in its courfe by the little river Shele; joins the Read near Billingham; and running in a direct line to the fouth-eaft, is united with the fouthern Tyne, forming a large river that wafhes Newcaftle, and falls into the German Ocean near Tinmouth.

In all probability the mountains of Northumberland contain lead-ore and other mineralized metals in their bowels, as they in all refpects refemble thofe parts of Wales and Scotland where lead mines have been found and profecuted. Perhaps the inhabitants are diverted from inquiries of this nature, by the certain profits and conftant employment they enjoy in working the coal-pits, with which this county abounds. The city of London, and the greateft part of England, are fupplied with fuel from thefe ftores of Northumberland, which are inexhauftible, enrich the proprietors, and employ an incredible number of hands and fhipping.

There are no natural woods of any confequence in this county; but many plantations belonging to the feats of noblemen and gentlemen, of which here is a great number. As for pot-herbs, roots, fallading, and every article of the kitchen-garden and orchard, they are here raifed in great plenty by the ufual means of cultivation; as are alfo the fruits of more delicate flavour, fuch as the apricot, peach, and nectarine. The fpontaneous fruits it produces in common with other parts of Great Britain, are the crab-apple, the floe or bullace, the hazle-nut, the acorn, hips, and haws, with the berries of the bramble, the juniper, wood-ftrawberries, cranberries, and bilberries.

Northumberland raifes a good number of excellent horfes and black cattle, and affords paftnre for numerous flocks of fheep; both the cattle and fheep are of a large breed, but the wool is coarfer than that which the more fouthern counties produce. The hills and mountains abound with a variety of game, fuch as red deer, foxes, hares, rabbits, heathcock, growfe, partridge, quail, plover, teal, and woodcock: indeed, this is counted one of the beft fporting counties in Great Britain. The fea and rivers are well ftocked with fifh; efpecially the Tweed, in which a vaft number of falmon is caught and carried to Tinmouth, where being pickled, they are conveyed by fea to London, and fold under the name of *Newcaftle falmon.*

The Northumbrians were anciently ftigmatized as a favage, barbarous people, addicted to cruelty, and inured to rapine. The truth is, before the union of the two crowns of England and Scotland, the borderers on each fide were extremely licentious and ungovernable, trained up to war from their infancy, and habituated to plunder by the mutual incurfions made into each kingdom; incurfions which neither truce nor treaty could totally prevent. People of a pacific difpofition, who propofed to earn their livelihood by agriculture, would not on any terms remain in a country expofed to the firft violence of a bold and defperate enemy: therefore the lands lay uncultivated, and in a great meafure deferted by every body but lawlefs adventurers, who fubfifted by theft and rapine. There was a tract 50 miles in length and 6 in breadth, between Berwick and Carlifle, known by the name of the *Debateable Land,* to which both nations laid claim, tho' it belonged to neither; and this was occupied by a fet of banditti who plundered on each fide, and what they ftole in one kingdom, they fold openly in the other: nay, they were fo dexterous in their occupation, that by means of hot bread applied to the horns of the cattle which they ftole, they twifted them in fuch a manner, that, when the right owners faw them in the market, they did not know their own property. Wardens were appointed to guard the marches or borders in each kingdom; and thefe offices were always conferred on noblemen of the firft character for influence, valour, and integrity. The Englifh border was divided into three marches, called the *eaft, weft,* and *middle marches;* the gentlemen of the country were conftituted deputy-wardens, who held march-courts, regulated the watches, difciplined the militia, and took meafures for affembling them in arms at the firft alarm: but in the time of peace between the two nations, they were chiefly employed in fuppreffing the infolence and rapine of the borderers. Since the union of the crowns, however, Northumberland is totally changed, both with refpect to the improvement of the lands, and the reformation of the inhabitants. The grounds, being now fecure from incurfion and infult, are fettled by creditable farmers, and cultivated like other parts of the kingdom. As hoftilities have long ceafed, the people have forgot the ufe of arms, and exercifed themfelves in the more eligible avocations of peace; in breeding fheep and cattle, manuring the grounds, working at the coal-pits, and in different branches of commerce and manufacture. In their perfons they are generally tall, ftrong, bold, hardy, and frefh-coloured; and though lefs unpolifhed than their anceftors, not quite fo civilized as their fouthern neighbours. The commonalty are well fed, lodged, and cloathed; and all of them remarkably diftinguifhed by a kind of *fhibboleth* or *whurle,* being a particular way of pronouncing the letter *R,* as if they hawked it up from the wind-pipe, like the cawing of rooks. In other refpects, the language they fpeak is an uncouth mixture of the Englifh and Scottifh dialects. There is no material diftinction between the fafhionable people of Northumberland, and thofe of the fame rank in other parts of the kingdom: the fame form of education will produce the fame effects in all countries. The gentlemen of Northumberland, however, are remarkable for their courage, hofpitality, and hard drinking.

A great number of Roman monuments have been found in this county; but the moft remarkable curiofity of that kind confifts in the remains of Hadrian's vallum and the wall of Severus See ADRIAN's *Wall,* and SEVERUS's *Wall.*

The moft noted towns in Northumberland, are Newcaftle, Morpeth, Alnwick, Berwick, Hexham, and North Shields.

NORWAY, a country of Europe, lying between the 57th and 72d degrees of north latitude, and between the 5th and 31ft degrees of longitude eaft from London; extending in length about 1000 miles, in a direct line from Lindefnaes, in the diocefe of Chri-

Chriſtianſand, to the North Cape, at the extremity of Finmark. Its breadth, from the frontiers of Sweden weſtward to Cape Statt, may amount to about 300 miles; but from thence the country becomes gradually narrower towards the north. On the ſouth it is bounded by the Schagen-rock, or Categate, the entrance into the Baltic; on the eaſt it is divided from Sweden by a long ridge of high mountains; and on the weſt and north it is waſhed by the northern ocean.

The coaſt of Norway, extending above 300 leagues, is ſtudded with a multitude of ſmall iſlands, affording habitation to fiſhermen and pilots, and paſture to a few cattle. They form an infinite number of narrow channels, and a natural barrier of rocks, which renders Norway inacceſſible to the naval power of its enemies. Attempts of this kind are the more dangerous, as the ſhore is generally bold, ſteep, and impending; ſo that cloſe to the rocks the depth of the ſea amounts to 100, 200, or 300 fathoms. The perils of the north ſea are moreover increaſed by ſudden ſtorms, ſunk rocks, violent currents, and dreadful whirlpools. The moſt remarkable vortex on this coaſt is called *Moſkoeſtrom*, from the ſmall iſland Moſke, belonging to the diſtrict of Lofoden in the province of Nordland. In time of flood, the ſtream runs up between Lofoden and Moſkoe with the moſt boiſterous rapidity; but in its ebb to the ſea, it roars like a thouſand cataracts, ſo as to be heard at the diſtance of many leagues. The ſurface exhibits different vortices; and if in one of theſe any ſhip or veſſel is abſorbed, it is whirled down to the bottom, and daſhed in pieces againſt the rocks. Theſe violent whirlpools continue without intervals, except for a quarter of an hour, at high and low water, in calm weather; for the boiling gradually returns as the flood or ebb advances. When its fury is heightened by a ſtorm, no veſſel ought to venture within a league of it. Whales have been frequently abſorbed within the vortex, and howled and bellowed hideouſly in their fruitleſs endeavours to diſengage themſelves. A bear, in attempting to ſwim from Lofoden to Moſkoe, was once hurried into this whirlpool, from whence he ſtruggled in vain for deliverance, roaring ſo loud as to be heard on ſhore; but, notwithſtanding all his efforts, he was borne down and deſtroyed. Large trees being abſorbed by the current, are ſucked down, and riſe again all ſhattered into ſplinters. There are three vortices of the ſame kind near the iſlands of Ferroe.

Norway is divided into the four governments of Aggerhus, Bergen, Drontheim, and Wardhus, beſides that of Bahus, which is now ſubject to Sweden. The province of Aggerhus comprehends the ſouth-eaſt part of Norway, extending in length about 300 miles. Its chief towns are Chriſtiania, the ſee of a biſhop, ſuffragan to the metropolitan ſee of Drontheim, where the ſovereign court of juſtice is held, in preſence of the viceroy and the governor of the province; Aggerhus, about 15 miles to the ſouthweſt of Chriſtiania; Frederickſhall, or Frederickſtadt, in the ſiege of which Charles XII. of Sweden loſt his life; Saltzberg, Tonſberg, Alleen, Hammar, and Hollen.

The government of Bergen lies in the moſt ſoutherly and weſterly part of Norway, including the city of the ſame name, which is an epiſcopal ſee, and a place of conſiderable trade; and Staff-hanger, ſituated in the bay of Buckenfior, about 80 miles to the ſouthward of Bergen. The third province, called *Drontheim* or *Trontheim*, extends about 500 miles along the coaſt; and is but thinly peopled. The chief town Drontheim, ſeated on a little gulph at the mouth of the river Nider, is the only Metropolitan ſee in Norway; and carries on a conſiderable trade in maſts, deals, tar, copper, and iron. Leetſtrand, Stronden, Scoerdale, Opdal, Romſdael, and Solendael, are likewiſe places of ſome traffic. The northern diviſion of Drontheim, called the *ſub-government of Salten*, comprehends the towns of Melanger and Scheen. The province of Wardhus, extending to the North Cape, and including the iſlands, is divided into two parts; namely, Finmark and Norwegian Lapland. The chief town, which is very inconſiderable, ſtands upon an iſland, called *Ward*, from whence the place and the government derive their name. The province of Bahus, though now yielded to the Swedes, is reckoned part of Norway, being a narrow track of land, about 90 miles in length, lying on the coaſt of the Categate.

The great chain of Norway mountains, running from north to ſouth, called indifferently *Rudfield*, *Sudefield*, *Skarsfield*, and *Scoreberg*, is known in different parts by other appellations; ſuch as *Dofrefield*, *Lamsfield*, *Sagnefield*, *Filefield*, *Halnefield*, *Hardangerfield*, *Joklefield*, *Byglefield*, *Hicklefield*, and *Hangfield*. The height and breadth of this extenſive chain likewiſe vary in different parts. To paſs the mountain Hardanger, a man muſt travel about 70 Engliſh miles whereas Filefield may be about 50 over. This laſt riſes about two miles and a half in perpendicular height; but Dofrefield is counted the higheſt mountain of Norway, if not of Europe. The river Drivane winds along the ſide of it in a ſerpentine courſe, ſo as to be met nine times by thoſe who travel the winter-road to the other ſide of the chain. The bridges are thrown over roaring cataracts, and but indifferently faſtened to the ſteep rocks on either ſide; ſo that the whole exhibits a very dreadful appearance, ſufficient to deter the traveller from hazarding ſuch a dangerous paſſage: for which reaſon, people generally chooſe the road over Filefield, which is much more tedious. This, however, is the poſt-road uſed by the king's carriages. The way is diſtinguiſhed by poſts fixed at the diſtance of 200 paces from each other, that, in ſnowy or dark weather, the traveller may not be bewildered. For the convenience of reſting and refreſhing, there are two mountain-ſtoves or houſes maintained on Filefield, as well as upon other mountains, at the expence of the public, and furniſhed with fire, light, and kitchen-utenſils. Nothing can be more diſmal and dreary than theſe mountains covered with eternal ſnow, where neither houſe, tree, nor living creature is to be ſeen, but here and there a ſolitary rein-deer, and perchance a few wandering Laplanders.

In travelling from Sweden to Nordenfields, there is only one way of avoiding this chain of mountains; and that is, where it is interrupted by a long deep valley, extending from Romſdale to Guldbrandſdale. In the year 1612, a body of 1000 Scots, commanded by Sinclair, and ſent over as auxiliaries to the Swedes, were put to the ſword in this defile, by the peaſants of Guld-

 Guldbrand, who never give quarter.

Befides this chain, there is a great number of detached mountains over all the country, that form valleys and ridges, inhabited by the peafants. Some of thefe are of incredible height, and others exhibit very remarkable appearances. In failing up Joering Creek on the left hand, the fight is aftonifhed with a groupe of mountains, refembling the profpect of a city, with old Gothic towers and edifices. In the parifh of Oerfkong is the high mountain Skopfhorn, the top of which reprefents the figure of a fortification, with regular walls and baftions. In the diftrict of Hilgeland appears a very high range of mountains, with feven pinnacles or crefts, known by the appellation of the *Seven Sifters*, difcernible a great way off at fea. To the fouthward of this range, though in the fame diftrict, rifes the famous mountain *Torghatten*, fo called becaufe the fummit refembles a man's head with a hat on, under which appears a fingle eye, formed by an aperture through the mountain, 150 ells high, and 3000 ells in length. The fun may be feen through this furprifing cavity, which is paffable by the foot of travellers. On the top of the mountain we find a refervoir of water, as large as a moderate fifh-pond: in the lower part is a cavern, through which a line 400 fathoms in length, being let down, did not reach the bottom. At Herroe in Sundmoer is another cavern called *Dolfteen*, fuppofed to reach under the fea to Scotland; which, however, is no more than an idle tradition. In the year 1750, two clergymen entered this fubterranean cavity, and proceeded a confiderable way, until they heard the fea dafhing over their heads: the paffage was as wide and high as an ordinary church, the fides perpendicular, and the roof vaulted. They defcended one flight of natural ftairs; but arriving at another, they were afraid to penetrate farther: they had gone fo far, however, that two candles were confumed in their progrefs and return. A cavern of a very curious nature, ferving as a conduit to a ftream of water, penetrates through the fides of the mountain Limur. In the diftrict of Rake, in the neighbourhood of Frederickfhall, are three cavities in a rock; one of which is fo deep, that a fmall ftone dropped down, does not reach the bottom in lefs than two minutes; and then the found it produces is pleafant and melodious, not unlike the found of a bell.

The vaft mountains and rugged rocks that deform the face of this country, are productive of numberlefs inconveniences. They admit of little arable ground: they render the country in fome parts impaffable, and every where difficult to travellers: they afford fhelter to wild beafts, which come from their lurking holes, and make terrible havock among the flocks of cattle: they expofe the fheep and goats, as well as the peafant, to daily accidents of falling over precipices: they occafion fudden torrents, and falls of fnow, which defcend with incredible impetuofity, and often fweep away the labours of the hufbandman; and they are fubject to dreadful difruptions, by which huge rocks are rent from their fides, and, hurling down, overwhelm the plains below with inevitable ruin. The peafants frequently build their houfes on the edge of a fteep precipice, to which they muft climb by ladders, at the hazard of their lives; and when a perfon dies, the corpfe muft be let down with ropes, before it can be laid in the coffin. In winter the mail is often drawn up the fides of fteep mountains. Even in the king's road, travellers are expofed to the frequent rifks of falling over thofe dreadful rocks; for they are obliged to pafs over narrow pathways, without rails or rifing on the fides, either fhored up with rotten pofts, or fufpended by iron bolts faftened in the mountains. In the narrow pafs of Naeroe is a remarkable way of this kind, which, above 600 years ago, the famous king Surre caufed to be made for the paffage of his cavalry; and even this would have been found impaffable by any other horfes than thofe of Norway, which are ufed to climb the rocks like goats. Another very difficult and dangerous road is that between Shogftadt and Vang in Volders, along the fide of a fteep mountain, in fome places fo narrow, that if two travellers on horfeback fhould meet in the night, they would find it impracticable either to pafs each other, or turn back. In fuch a cafe their lives could not be faved, unlefs one of them fhould alight, and throw his horfe headlong into the lake below, and then cling to the rock, until the other could pafs. When a fheep or goat makes a falfe ftep to the projection of a rock, from whence it can neither afcend nor defcend, the owner hazards his own life to preferve that of the animal. He directs himfelf to be lowered down from the top of the mountain, fitting on a crofs ftick, tied to the end of a long rope; and when he arrives at the place where the creature ftands, he faftens it to the fame cord, and it is drawn up with himfelf. Perhaps the other end of the rope is held by one perfon only; and there are fome inftances, in which the affiftant has been dragged down by the weight of his friend, fo that both have perifhed. When either man or beaft has had the misfortune to fall over very high precipices, they have not only been fuffocated by the repercuffion of the air, but their bodies have been always burft before they reached the ground. Sometimes entire crefts of rocks, many fathoms in length and breadth, have fallen down at once, creating fuch a violent agitation of the air, as feemed a prelude to the world's diffolution. At Steenbroc in Laerdale, a ftupendous mafs, larger than any caftle in the univerfe, appears to have been fevered and tumbled from the mountain in large, fharp, and ragged fragments, thro' which the river roars with hideous bellowing. In the year 1731, a promontory on Sundmoer, called *Rammersfield*, that hung over Nordal Creek, fuddenly gave way, and plunged into the water; which fwelled to fuch a degree, that the church of Strand, tho' half a league on the other fide of the bank, was overflowed: the creek, however, was not filled up; on the contrary, the fishermen declare they find no difference in the depth, which is faid to exceed 900 fathoms.

The remarkable rivers of Norway are thefe: The Nied, iffuing from Tydalen, on the borders of Sweden, runs weftward into the lake Selboe; and afterwards, turning to the northward, paffes by the city of Drontheim, to which it anciently gave the name of *Nideros* and *Nidrofia*: Sule Ely, that defcending from Sulefield, runs with a rapid courfe thro' Nordale into the fea: Gulen, which rifes near Sffarsfield in the north; and running 20 leagues weftward, thro' Aalen, Hlotaalen, Storen, and Melhuus, difcharges itfelf into the fea, about a league to the weft of Drontheim. In

Norway. In the year 1344, this river buried itſelf under ground: from whence it again burſt forth with ſuch violence, that the earth and ſtones thrown up by the eruption, filled the valley, and formed a dam; which, however, was ſoon broken and waſhed away by the force of the water. Divers churches, 48 farm-houſes, with 250 perſons, were deſtroyed on this occaſion. Otteroen, a large river, taking its riſe from the mountain Agde, runs about 30 leagues through Seeterdale and Efie, and diſembogues itſelf into the cataract of Wiland. The river Syre riſes near the mountain Lang, and winds its courſe thro' the vale of Syre into the lake of Lunde in the dioceſe of Chriſtianſand: thence it continues its way to the ſea, into which it diſcharges itſelf through a narrow ſtrait formed by two rocks. This contraction augments its impetuoſity, ſo that it ſhoots like an arrow into the ſea, in which it produces a very great agitation. Nid and Sheen are two conſiderable rivers, iſſuing out of Tillemark. Their water-falls have been diverted, with infinite labour, by canals and paſſages cut through the rocks, for the convenience of floating down the timber. Tyrefiord, or Dramme, is in the neighbourhood of Honifoſſe, joined by two rivers from Oedale and Hadeland, and diſembogues iſelf into the ſea near Bragneſs. Loven riſes in the higheſt part of Nummedal, and runs through Konſberg to the ſea near Laurwig. Glaamen is the largeſt river of Norway, diſtinguiſhed by the name of *Stor-Elvin*, or the *great river*. It derives its origin from the mountain Doſre, from whence it winds all along the plains of Oeſterdale and Soloe; then joins the Vorme, another conſiderable river riſing out of Mioes and Guldſbrandſdale. Theſe being joined, traverſe the lake Oeyeren; and thence iſſuing, run on to Sarp near Frederickſtadt.

Norway abounds with freſh-water lakes; the principal of which are, Ryſvand in Nordland, Snaaſen, Selboe, the Greater and Leſſer Mioes, Slirevand, Sperdille, Rand, Veſtn, Saren, Modum, Lund, Norſoe, Huidſoe, Fariſvand, and Oeyevand: all theſe are well ſtocked with fiſh, and navigable for large veſſels. Wars have been formerly carried on upon theſe inland ſeas; in ſome of which are ſmall floating iſlands, or parcels of earth with trees on them, ſeparated from the main land, and probably preſerved in compact maſſes by the roots of trees, ſhrubs and graſs, interwoven in the ſoil. In the year 1702, the family-ſeat of Borge, near Frederickſtadt, being a noble edifice, with lofty towers and battlements, ſuddenly ſunk into an abyſs 100 fathoms deep, which was inſtantaneouſly filled by a piece of water 300 ells in length, and about half as broad. Fourteen perſons, with 200 head of cattle, periſhed in this cataſtrophe, which was occaſioned by the river Glaamen precipitating itſelf down a water-fall near Sarp, and undermining the foundation. Of all the water-falls in Norway this of Sarp is the moſt dangerous for its height and rapidity. The current drives 17 mills; and roars with ſuch violence, that the water, being daſhed and comminuted among the rocks, riſes in the form of rain, where a beautiful rainbow may be always ſeen when the ſun ſhines. In ancient times this cataract was made uſe of for the execution of traitors and other malefactors: they were thrown down alive, that they might be daſhed in pieces on the points of rocks, and die in a dreadful commotion, analagous to thoſe they had endeavoured to excite in the community. Norway.

Great part of Norway is covered with foreſts of wood, which conſtitute the principal article of commerce in this country. They chiefly conſiſt of fir and pine, for which great ſums are received from foreigners, who export an immenſe number of maſts, beams, planks, and boards. Beſides, an incredible quantity is conſumed at home, in building houſes, ſhips, bridges, piles, moles, and fences; over and above the vaſt demand for charcoal to the founderies, and fewel for domeſtic uſes. Nay, in ſome places, the trees are felled for no other purpoſe but to clear the ground and to be burned into aſhes for manure. A good quantity of timber is yearly exported to Scotland and Spain: but this is inconſiderable when compared to the vaſt exports from Drammen, Frederickſhall, Frederickſtadt, Chriſtiania, Skeen, Arendal, Chriſtianſand, Chriſtian's-bay, and Drontheim. The maſts and large beams are floated down the rivers, and the reſt is divided into boards at the ſaw-mills. Theſe works ſupply a vaſt number of families with a comfortable ſubſtance. A tenth part of all ſawed timber belongs to his Daniſh majeſty, and makes a conſiderable branch of his revenue. The foreſts in Norway are ſo vaſt and thick, that the people ſeem to think there can never be a ſcarcity of wood, eſpecially as the ſoil is peculiarly adapted for the production of timber: they therefore deſtroy it with a waſteful hand; inſomuch that more wood rots in Norway than is burned in the whole kingdom of Denmark. The beſt timber grows in the provinces of Saltan, Helleland, Romſdale, Guldbrandſdale, Oeſterdale, Soloe, Valders, Hallingdale, Sognifiord, Tellemark, and the lordſhip of Nedene.

The climate of Norway is very different in different parts of the kingdom. At Bergen the winter is ſo moderate, that the ſeas are always open and practicable both to mariners and fiſhermen, except in creeks and bays, that reach far up into the country towards Filefield, when the keen north-eaſt wind blows from the land. On the eaſt ſide of Norway from the frontiers of Sweden to Filefield, the cold generally ſets in about the middle of October with great ſeverity, and laſts till the middle of April; during which interval the waters are frozen to a very conſiderable thickneſs, and the face of the country is covered with ſnow. In the year 1719, 7000 Swedes, who intended to attack Drontheim, periſhed in the ſnow on the mountain of Ruden or Tydel, which ſeparates Jempteland in Sweden from the dioceſe of Drontheim. A company of 200 Norwegian ſledgemen under major Emahus, found them all frozen to death on the ridge of the mountain, where they had been ſurpriſed by a ſtorm accompained with ſnow, hail, and extreme cold. Some of theſe unhappy victims appeared ſitting, ſome lying, and others kneeling in a poſture of praying. They had cut in pieces their muſkets, and burned the little wood they afforded. The generals Labarre and Zoega loſt their lives; and of the whole corps, conſiſting originally of 10,000, no more than 2500 ſurvived this dreadful cataſtrophe.

The cold is ſtill more intenſe in that part of Norway called *Finmark*, ſituated in the frigid zone near the

the polar circle. But if the winter is generally cold, the ſummer is often exceſſively hot, in Norway. The rays of the ſun are reverberated from the ſides of the mountains ſo as to render the weather cloſe and ſultry in the valleys; beſides the ſun's abſence below the horizon is ſo ſhort, that the atmoſphere and mountains have not time to cool. The heat is ſo great, that vegetation is remarkably quick. Barley is ſown, grows, ripens, and is reaped, in the ſpace of ſix weeks or two months.—The longeſt day at Bergen conſiſts of 19 hours; the ſun riſing at half an hour after two, and ſetting at half an hour after nine. The ſhorteſt day does not exceed ſix hours; for the ſun riſes at nine in the morning, and ſets at three in the afternoon. In the beginning of the year the daylight increaſes with remarkable celerity; and, at the approach of winter, decreaſes in the ſame proportion. In ſummer one may read and write at midnight by the light of the ſky. Chriſtian V. while he reſided at Drontheim, uſed to ſup at midnight without candles. In the diſtrict of Tromſen, at the extremity of Norway, the ſun is continually in view at midſummer. It is ſeen to circulate day and night round the north pole, contracting its orbit, and then gradually enlarging it, until at length it leaves the horizon. In the depth of winter, therefore, it is for ſome weeks inviſible; and all the light perceived at noon is a faint glimmering for about an hour and an half, proceeding from the reflection of the ſun's rays from the higheſt mountains. But the inhabitants of theſe provinces are ſupplied with other lights that enable them to follow their employments in the open air. The ſky being generally ſerene, the moonſhine is remarkably bright, and, being reflected from the mountains, illuminates the valleys. They are alſo aſſiſted by the Aurora Borealis, which is very frequent in the northern parts of Europe.

The air of Norway is generally pure and ſalubrious. On the ſea-coaſts, indeed, it is rendered moiſt by vapours and exhalations: but in the midland parts of the country, towards the mountains, the climite is ſo dry, that meal may be kept for many years without being worm eaten or damaged in the leaſt. The inhabitants have no idea of ſickneſs except what is occaſioned by exceſſes. It is ſaid that in the vale of Guldbrand the inhabitants live to ſuch extreme old age, that they become weary of life, and cauſe themſelves to be removed to a leſs ſalubrions climate, whereby they may have a chance of dying the ſooner. In conſumptions, however, the moiſt air on the ſea-ſide is found to be moſt agreeable to the lungs in reſpiration. Norway, being a mountanious country interſected by creeks, abounding with lakes, rivers, and ſnow, muſt be ſubject to frequent rains; and from ſudden thaws the inhabitants are ſometimes expoſed to terrible diſaſters. Vaſt maſſes of ſnow falling from precipices, overwhelm men, cattle, boats, houſes, nay even whole villages. About two centuries ago, a whole pariſh was covered and deſtroyed by an immenſe maſs of ſnow; and ſeveral domeſtic utenſils, as ſciſſars, knives, and baſons, have been at different times brought to light by a rivulet that runs under the ſnow, which has been gradually hardened and increaſed by repeated froſts and annual acceſſions.

The winds that chiefly prevail on the weſtern coaſt are thoſe that blow from the ſouth; whereas, on the other ſide of Fileſield, the winds that produce and continue the hard froſts are always northerly. In the ſummer, there is a kind of regular trade-wind on the coaſt of Bergen. In the forenoon the ſea begins to be cooled with a weſterly breeze, which continues till midnight. Then the land breeze begins from the eaſt, and blows till about ten in the morning. The coaſt is likewiſe ſubject to ſudden ſqualls and ſtorms. Hurricanes ſometimes riſe at ſea; and in theſe latitudes the phænomenon called a *water-ſpout* is not uncommon. One of theſe in the neighbourhood of Ferro is ſaid to have ſucked up with the water ſome laſts of herrings, which were afterwards dropped on Kolter, a mountain 1200 feet high.

The freſh-water of Norway is not very light or pure; but on the contrary is generally turbid, and depoſits a ſediment of adventitious matter, being ſometimes impregnated with oker, and particles of iron. Nevertheleſs it is agreeable to the taſte, and remarkably ſalubrious; as appears from the good health of the common people, who drink little or no other liquor.

The ſoil of Norway varies in different places according to the ſituation of rock or valley. The mountains here, as in every other country, are bare and barren; but the earth waſhed down from them by the rains, enriches and fertilizes the valleys. In theſe the ſoil generally conſiſts of black mould, ſand, loam, chalk and gravel, lying over one another in unequal ſtrata, and ſometimes in three or four ſucceſſions: the mould that lies uppermoſt is very fine and mellow, and fit to nouriſh all ſorts of vegetables. There is alſo clay found in different parts of this kingdom, of which the inhabitants begin to make earthen ware; but bricks and tiles are not uſed in building. The face of the country is in many places deformed by large ſwamps and marſhes, very dangerous to the traveller. Near Leeſſoe in the dioceſe of Chriſtianſand, a wooden cauſeway is extended near a mile over a moraſs; and if a horſe or any other animal ſhould make a falſe ſtep, he will ſink at once into the abyſs never to riſe again.

In a cold country like Norway, roughened with rocks and mountains, interſperſed with bogs, and covered with foreſts, we cannot expect to find agriculture in perfection. The ploughed lands, in reſpect to mountains, woods, meadows, and waſtes, do not exceed the proportion of 1 to 80; ſo that the whole country does not produce corn to maintain above half the number of its inhabitaats. The peaſants are diſcouraged from the practice of huſbandry by the frequency of accidents that ſeem peculiar to the climate. Even in the fruitful provinces of Guldbrandſdale, Oeſterdale, and Soloer, as well as in other places, when the corn appears in the moſt flouriſhing condition, the whole hope of the harveſt is ſometimes deſtroyed in one night by a ſudden froſt that nips the blade and extinguiſhes the vegetation. The kingdom is moreover viſited by ſome unfavourable years, in which the ſun ſeems to have loſt his genial power; the vegetables are ſtunted; the trees bud and bloom, yet bear no fruit; and the grain, though it riſes, will yet produce nothing but empty ears and ſtraw. This calamity, however, rarely occurs; and in general the cultivated parts of Norway yield plentiful crops of excellent

Norway. cellent rye, barley, and oats. The moft fruitful provinces are Nordland, Inderbarre, and Numedale, in the diocefe of Drontheim; Sognifiord, and Vaas in that of Bergen; Jedderen, Ryefylfk, Raabygdelag, and the lordfhip of Nedenes, in the diocefe of Chriftianfand; Hedemark in the diocefe of Aggerhuis; Hadeland, Toten, Romerige, Ringerige, and Guldbrandfdale: thefe territories not only produce grain enough for their own confumption, but likewife fupport their neighbours, and even fupply part of Sweden. Peafe are likewife propagated in this country, together with wheat, buck-wheat, hops, hemp and flax, but not to any confiderable advantage. The meadows are well ftored with pafturage for fheep and cattle, and the fields are productive of thofe vegetables which are common in other northern countries. Within thefe 50 years the people of Norway have beftowed fome attention on the culture of gardens, which in former times was fo neglected, that the cities and towns were fupplied with leeks, cabbage, and roots, from England and Holland. At prefent, however, the Norwegians raife their own culinary and garden roots and vegetables, which thrive there as well as in any other country. The fcurvy being a difeafe that prevails along the fea-coaft, Nature has fcattered upon it a variety of herbs efficacious in the cure of that diftemper; fuch as angelica, rofe-wort, gentian, creffes, trefoil, forrel, fcurvy-grafs, and a plant called *erich's grafs*, that grows in great plenty on the iflands of Northland; from whence the people of the continent fetch away boat-loads of it, to be preferved in barrels as a fuccedaneum for cabbage. There are alfo a few noxious vegetables little known in any country but Norway. In Guldbrandfale is a fpecies of grafs called *felfnape*; the root of which is fo poifonous, that any beaft which eats of it dies immediately, the belly burfting; nay, the carnivorous fowls that prey upon the carcafe of the beaft meet with the fame fate: children have been more than once poifoned by this root which neverthelefs is fometimes ufed externally as an amulet for arthritic diforders. Another vegetable pernicious to the cattle is the *Gramen offifragum Norwegienfe*, which is faid to mollify the bones of the cattle which feed upon it. Among the noxious plants of Norway we may alfo reckon the igle-grafs, fatal to fheep and goats; the tour-grafs, which affects horfes and cows with a fort of lethargy; and the plant torboe, or hifte-fpring, which produces nearly the fame effect on horfes, but is not at all prejudicial to cows, fheep, or any ruminating animals. The herb turte, not unlike angelica, operates nearly in the fame manner: yet the bears are faid to feed upon it with peculiar relifh; and when their hair begins to fall off by feeding upon this plant, they cure themfelves by eating the flefh of animals.

The common fruit-trees thrive tolerably well in Norway, the inhabitants of which have plenty of cherries, apples, and pears. Some kinds of plums attain maturity; which is feldom the cafe with grapes, apricots, and peaches. But even the apples and pears that ripen here are fummer-fruit; that which grows till the winter feldom coming to perfection. Great variety of agreeable berries are produced in different parts of this kingdom; fuch as the hagebar, a kind floes; an infufion of which in wine makes a pleafant cooling liquor; juniper-berries, corinths red and white, foelbar or fun-berries, rafpberries, goofeberries, blackberries, ftrawberries, &c. with many other fpecies that feem to be natives of Norway and Sweden. Among thofe are the tranæbar, the produce of the myrtillus repens, red and auftere, found in the fpring in perfection under the fnow, and much relifhed by by the reindeer; crakebeer, refembling bilberries, deemed a powerful antifcorbutic; agerbeer, larger and blacker than bilberries, of a pleafant acid, ripened by cold, and ufed as cherries for an infufion in wine: and finally tylte-beer, a red pleafant berry growing on a fhort ftem, with leaves like thofe of box: they are plucked off by handfuls, and fent to Denmark to be preferved for the table, where they are eaten by way of defert.

Of the trees that grow wild in Norway, the principal are the fir and the pine. The firft yield an annual revenue of 1,000,000 of rix-dollars, if we include the advantages refulting from the faw-mills and the mafts; one of which laft has been known to fell for 200 rix-dollars. The red fir-tree, which grows on the mountains, is fo rich in turpentine as to be almoft incorruptible. Some of the houfes belonging to the Norway peafants, built of this timber, are fuppofed to be above 400 years ftanding. In Guldbrandfdale the houfe is ftill to be feen ftanding in which king Olaf lodged five nights, above 700 years ago, when he travelled round the kingdom to convert the people to the Chriftian faith. Even 100 years after the trunk of the fir-tree has been cut down, the peafants burn the roots for tar, which is a very profitable commodity. In the fens, the refin of the fir-tree is by nature transformed into a fubftance which may be called *Norway frankincenfe*. The buds or pine-apples of this tree, boiled in ftale beer, make an excellent medicine for the fcurvy; lefs unpleafant to the tafte, though as efficacious, as tar-water. The pine-tree is more tall and beautiful than the fir, though inferior to it in ftrength and quality; for which reafon the planks of it are fold at an inferior price, and the peafants wafte it without remorfe. Norway likewife produces fome forefts of oak, which is found to be excellent for fhip-building. Here alfo grow plenty of elm-trees; the bark of which, being powdered, is boiled up with other food to fatten hogs, and even mixed by the poor among their meal: alfo the afh, from which the peafants diftill a balfam ufed in certain diforders, and which is ufed both externally and internally. Many other trees flourifh in this country, an enumeration of which would prove too tedious. Hazles grow here in fuch abundance, that 100 tons of the nuts are annually exported from Bergen alone.

A great diverfity of ftones is found in Norway, fome of which are of a furprifing figure. Several mountains confift chiefly of a brown pebble, which decays with age; nay, it fometimes diffolves, and drops into the fea, and, the cement being thus loofened, a terrible difruption enfues. In fome places the grey and black pebbles are intermixed with iron, copper, lead, filver, and gold. The ground, in certain diftricts, is covered with the fragments of rocks that have been precipitated from the fummits of mountains, and broken by their fall into innumerable fhivers. Between 20 and 30 years ago, in the neighbourhood of Bergen, a man

man was ſuddenly overwhelmed with ſuch a maſs, which formed a kind of vault around him. In this dreadful tomb he remained alive for ſeveral weeks. By his loud cries the place of his confinement was diſcovered; but it was found impoſſible to remove the huge ſtones by which he was incloſed. All that his friends could do for him was, to lower down meat and drink through ſome crevices; but at length the ſtones fell in, and cruſhed him to death.

In Norway are inexhauſtible quarries of excellent marble, black, white, blue, grey, and variegated; together with ſome detached pieces of alabaſter, ſeveral kinds of ſpar, chalk-ſtone, cement-ſtone, ſand-ſtone, mill-ſtone, baking-ſtone, ſlate, talc, magnets; and ſwine-ſtone, a production natural to Norway and Sweden, of a brown colour, fetid ſmell, in texture reſembling cryſtal, and deriving its name from a ſuppoſed efficacy in curing a diſtemper incident to ſwine. Here alſo is found the amianthus or ſtone-flax, of which incombuſtible cloth may be made. Norway, however, affords no flints, but plenty of pyrites or quartz, beautiful cryſtals, granates, amethyſts, agate, thunder-ſtones, and eagle-ſtones. Gold has formerly been found in a ſmall quantity in the dioceſe of Chriſtianſand, and coined into ducats. There is at preſent a very conſiderable ſilver-mine wrought at Kongſberg on the account and riſk of his Daniſh majeſty: the ore is ſurpriſingly rich, but interrupted in ſuch a manner, that the vein is often loſt. Many maſſes of pure ſilver have been found; and, among the reſt, one piece weighing 560 pounds, preſerved in the royal muſeum at Copenhagen. Such is the richneſs of theſe mines, that the annual produce amounts in value to a tun and an half in gold. About 5000 people are daily employed, and earn their ſubſiſtence, in thoſe ſtupendous works. Other ſilver-mines are proſecuted at Jarlſberg, but not to the ſame advantage; and here the ore is mixed with lead and copper. In many parts of this country copper-mines have been diſcovered; but the principal, and perhaps the richeſt in all Europe, is at Roraas, about 100 Engliſh miles from Drontheim. This work yields annually about 1100 ſhip-pounds of pure copper: the founderies belonging to it conſume yearly about 14,000 laſts of coal, and 500 fathoms of wood. The next in importance is the copper-work at Lykken, about 20 miles from Drontheim. A third mine is carried on at Indſet, or Quickne, at the diſtance of 30 miles from the ſame place; and here they precipitate the copper from its menſtruum, by means of iron. There is a fourth copper-work at Silboe, about 30 miles diſtant from Drontheim, though the leaſt conſiderable of the four. Other copper-mines of leſs note are worked in different parts of the kingdom. Iron is ſtill in greater plenty, and was the firſt metal wrought in this country. Many hundred thouſand quintals are annually exported, chiefly in bars, and part of it in ſtoves, pots, kettles, and cannon: the national profit ariſing from this metal is eſtimated at 300,000 rix-dollars. There is a ſpecies called *moor-iron*, found in large lumps among the moraſſes: of this the peaſants make their own domeſtic tools and utenſils, ſuch as knives, ſcythes, and axes. The lead found mixed in the ſilver ore is an article of ſmall importance in Norway; yet ſome mines of this metal have been lately opened in the diſtrict of Soloer, by the proprietors of the copper-work at Oudal. A vitriol work has been begun near Kongſberg: the mines yield great plenty of ſulphur; which, however, the Norwegians will not take the trouble to melt and depurate, becauſe immenſe quantities are found at a cheaper rate in the iſland of Iceland. Alum is found between the ſlate-flakes near Chriſtiana in ſuch plenty, that works have been ſet up for refining this mineral, though they have not yet brought it to any degree of tranſparency. His Daniſh majeſty has eſtabliſhed ſalt-works in the peninſula of Valoe, about ſix Engliſh miles from Tonſberg, where this mineral is extracted in large quantities from the ſea-water.

Beſides the animals common to other countries, Norway is ſaid to contain many of the uncommon and dubious kind; ſuch as the kraken, mermaid, ſea-ſerpent, &c. See theſe articles.

Many Daniſh, Engliſh, Scotch, Dutch, and German families have ſettled in Norway, and now form no inconſiderable part of the trading people: but the original inhabitants are the deſcendants of thoſe ferocious Normanni, who harraſſed almoſt all the coaſts of Europe with piratical armaments in the 8th, 9th, and 10th centuries. They ſpeak the ſame language that is uſed in Denmark, though their original tongue is the dialect now ſpoken in Iceland. They profeſs the Lutheran religion, under an archbiſhop eſtabliſhed at Drontheim, with four ſuffragans; namely, of Bergen, Staffanger, Hammer, and Chriſtiana. By the union of Calmar, the two kingdoms of Norway and Denmark were united under one monarch; and then the people of both nations enjoyed conſiderable privileges: but the Daniſh government is now become abſolute; and Norway is ruled deſpotically by a viceroy, who reſides in the capital, and preſides in the ſupreme court, to which appeals are made from the ſubordinate courts of judicature.

The Norwegians are generally well-formed, tall, ſturdy, and robuſt, brave, hardy, honeſt, hoſpitable, and ingenious: yet ſavage, raſh, quarrelſome, and litigious. The ſame character will nearly ſuit the inhabitants of every mountainous country in the northern climates. Their women are well-ſhaped, tall, comely, remarkably fair and obliging. The nobility of Norway have been chiefly removed by the kings of Denmark, in order to prevent faction, and oppoſition to the court; or are long ago degenerated into the rank of peaſants: ſome families, however, have been lately raiſed to that dignity. Every freeholder in Norway enjoys the right of primogeniture, and power of redemption; and it is very uſual to ſee a peaſant inhabiting the ſame houſe which has been poſſeſſed 400 years by his anceſtors. The *odels-gads*, or freehold, cannot be alienated by ſale or otherwiſe from the right heir, called *odels-mand:* if he is not able to redeem the eſtate, he declares his incapacity every 10th year at the ſeſſions; and if he, or his heirs, to the third generation, ſhould acquire wealth enough for that purpoſe, the poſſeſſor *pro tempore* muſt reſign his poſſeſſion.

The mountaineers acquire ſurpriſing ſtrength and dexterity by hard living, cold, laborious exerciſe, climbing rocks, ſkating on the ſnow, and handling arms, which they carry from their youth to defend themſelves againſt the wild beaſts of the foreſts. Thoſe who

dwell

Norway. dwell in the maritime parts of Norway exercife the employments of fifhing and navigation, and become very expert mariners.

The peafants of Norway never employ any handicraftfmen for neceffaries to themfelves and families: they are their own hatters, fhoe-makers, taylors, tanners, weavers, carpenters, fmiths, and joiners: they are even expert at fhip-building; and fome of them make excellent violins. But their general turn is for carving in wood, which they execute in a furprifing manner with a common knife of their own forging. They are taught in their youth to wreftle, ride, fwim, fkate, climb, fhoot, and forge iron. Their amufements confift in making verfes, blowing the horn, or playing upon a kind of guitarre, and the violin: this laft kind of mufic they perform even at funerals. The Norwegians have evinced their valour and fidelity in a thoufand different inftances. The country was always diftracted by inteftine quarrels, which raged from generation to generation. Even the farmers ftand upon their punctilio, and challenge one another to fingle combat with their knives. On fuch occafions they hook themfelves together by their belts, and fight until one of them is killed or mortally wounded. At weddings and public feafts they drink to intoxication, quarrel, fight, and murder generally enfues. The very common people are likewife paffionate, ambitious of glory and independence, and vain of their pedigree. The nobility and merchants of Norway fare fumptuoufly; but the peafant lives with the utmoft temperance and frugality, except at feftivals: his common bread is made of oat-meal, rolled into broad thin cakes, like thofe ufed in Scotland. In time of fcarcity, they boil, dry, and grind the bark of the fir-tree into a kind of flour which they mix with oat-meal: the bark of the elm-tree is ufed in the fame manner. In thofe parts where a fifhery is carried on, they knead the roes of cod with their oatmeal. Of thefe laft, mixed with barley-meal, they make hafty-pudding, and foup, enriched with a pickled herring or falted mackarel. Frefh fifh they have in plenty on the fea-coaft. They hunt and eat growfe, partridge, hare, red deer, and rein-deer. They kill cows, fheep, and goats, for their winter ftock: thefe they pickle, or fmoke, or dry for ufe. They make cheefe of their milk, and a liquor called *fyre* of their four whey: this they commonly drink mixed with water; but they provide a ftore of ftrong ale for Chriftmas, weddings, chriftenings, and other entertainments. From their temperance and exercife, joined to the purity and elafticity of their air, they enjoy good health, and often attain to a furprifing degree of longevity. Nothing is more common than to fee a hearty Norwegian turned of 100. In the year 1733, four couples danced before his Danifh majefty at Fredericks-hall: their ages, when joined, exceeded 800 years. Neverthelefs, the Norwegians are fubject to various difeafes; fuch as the fcab, the leprofy, the fcurvy, the catarrh, the rheumatifm, gout, and epilepfy. The drefs of the Norway peafants confifts of a wide loofe jacket made of coarfe cloath, with waiftcoat and breeches of the fame. Their heads are covered with flapped hats, or caps ornamented with ribbons. They wear fhoes without foles, and in the winter leathern bufkins. They have likewife fnow-fhoes and long fkates, with which they travel at a great pace, either on the land or ice. There is a corps of foldiers thus accoutred, who can out-march the fwifteft horfes. The Norwegian peafant never wears a neckcloth, except on extraordinary occafions: he opens his neck and breaft to the weather, and lets the fnow beat into his bofom. His body is girt round with a broad leathern belt, adorned with brafs plates, from which depends a brafs chain that fuftains a large knife, gimlet, and other tackle. The women are dreffed in clofe-laced jackets, having leathern girdles decorated with ornaments of filver. They likewife wear filver chains round their necks, to the ends of which are fixed gilt medals. Their caps and handkerchiefs are almoft covered with fmall plates of filver, brafs, and tin, large rings, and buttons. A maiden bride appears with her hair platted, and, together with her cloaths, hung full of fuch jingling trinkets. Norway.

The churches, public edifices, and many private houfes in Norway, are built of ftone: but the people in general live in wooden houfes, made of the trunks of fir and pine-tree laid upon each other, and joined by mortifes at the corners. Thefe are counted more dry, warm, and healthy, than ftone or brick buildings. In the whole diocefe of Bergen, one hardly fees a farm-houfe with a chimney or windows: they are generally lighted by a fquare hole in the top of the houfe, which lets in the light, and lets out the fmoke. In fummer this hole is left quite open: in the winter, it is covered with what they call a fiau; that is, the membrane of fome animal, ftretched upon a wooden frame that fits the hole, and tranfmits the rays of light. It is fixed or removed with a long pole, occafionally. Every perfon that enters the houfe, upon bufinefs or courtfhip, takes hold on this pole, according to ancient cuftom. The ceiling is about eight feet high in the middle; and, being arched like a cupola, the fmoke of the fire underneath rolls about, until it finds a vent at the hole, which is called *liur*. Under this opening ftands a thick table with benches, and an high feat at the upper end for the mafter of the family: he has likewife a fmall cupboard for his own ufe, in which he locks up his moft valuable effects. The boards of the roof are coated with the bark of birch-trees, which is counted incorruptible: this again is covered with turf, which yields a good crop of grafs for goats and fheep, and is often mowed as hay by the farmer.

The Norwegians carry on a confiderable trade with foreign nations. The duty on the produce of their own country exported, amounts annually to 100,000 rix-dollars. Thefe commodities are, copper wrought and unwrought; iron caft into cannon, ftoves, and pots, or forged into bars; lead, in fmall quantity; mafts, timber, deal-boards, planks, marble, millftones, herring, cod, ling, falmon, lobfters, flounders, cow-hides, goat-fkins, feal-fkins, the furs of bears, wolves, foxes, beavers, ermins, martens, &c. down, feathers, butter, tallow, train-oil, tar, juniper and other forts of berries, and nuts; falt, alum, glafs, vitriol, and pot-afhes. All other commodities and articles of luxury, the Norwegians import from different nations. The nature of the ground does not admit of much improvement in agriculture: neverthelefs, the farmers are not deficient in induftry, and fkill

to

to drain marfhes, and render the ground arable and fit for pafture. Many are employed in grazing and breeding cattle: but a much greater number is engaged in felling wood, floating timber, burning charcoal, and extracting tar from the roots of the trees which have been cut down; in the filver, copper, and iron mines; in the navigation and fifhery. A confiderable number of people earn a comfortable livelihood by hunting, fhooting, and bird-catching. Every individual is at liberty to purfue the game, efpecially in the mountains and commons: therefore every peafant is expert in the ufe of fire-arms; and there are excellent markfmen among the mountains, who make ufe of the bow to kill thofe animals whofe fkins, being valuable, would be damaged by the fhot of fire arms.

Norway can produce above 14,000 excellent feamen. The army of this country amounts to 30,000 effective men; and the annual revenue exceeds 800,000 rixdollars.

Norway-*Rat*, in zoology. See Mus.

NORWICH, the capital of the county of Norfolk in England, fituated in E. Long. 1. 26. N. Lat. 52. 40. It is fuppofed to have had its name, which fignifies "a caftle to the north," from its fituation in refpect of Caftor, the ancient Venta Icenorum, three or four miles to the fouth of it, out of whofe ruins it feems to have rifen. In its infancy, in the reign of Etheldred, it was plundered and burnt by Sueno the Dane, when he invaded England with a great army. Afterwards it recovered; and in the reign of Edward the Confeffor was a confiderable place, having 1320 burghers. But it fuffered again much in the reign of William I. by being the feat of a civil war, which Ralph, earl of the Eaft Angles, raifed againft that king. So much was it impaired by the fiege it then underwent, that there were fcarce 560 burghers left in it, as appears from Doomfday-book. From that time forward it began by little and little to recover, efpecially after bifhop Herbert tranflated the epifcopal fee hither from Thetford in the reign of William Rufus in 1096; and built a beautiful cathedral, of which he himfelf laid the firft ftone, with this infcription, *Dominus Herbertus pofuit primum lapidem, in Nomine Patris, Filii, & Spiritus Sancti*, Amen, i. e. "Lord (bifhop) Herbert laid the firft ftone, in the name of the Father, Son, and Holy Ghoft;" and by a licence from pope Pafchal, declared it the mother-church of Norfold and Suffolk. After this, as Malmfbury has it, it became a town famous for merchandize and the number of inhabitants. Yet it was miferably harraffed in the reign of Henry II. by Hugh Bigod, earl of Norfolk, who was an adherent of Henry's fon, called the *junior king*. In the time of Edward I. it was walled round by the citizens, who had prefented a petition to Parliament for liberty to do it. Henry IV. allowed them, inftead of bailiffs, which they had before, to elect a mayor yearly, and made the city a county of itfelf. In the year 1348, near 58 perfons were carried off by the plague; and in 1507, the city was almoft confumed by fire. For the flourifhing ftate to which the city is now arrived, they are much indebted to the Flemings, who fled hither from the tyranny of the duke of Alva and the inquifition, and taught them the manufacture of thofe ftriped and flowered damafks, camblets, druggets, black and white crape, for which the place is now fo noted, and which have been computed to yield fometimes 160,000 l. a-year. In the year 1583, the citizens, by the help of an engine, conveyed water thro' pipes to the higheft parts of the city, which is pleafantly feated along the fide of a hill, extending a mile and a half in length from north to fouth; but the breadth is much lefs, and it contracts itfelf by degrees towards the fouth. It is now one of the moft confiderable cities in Britain for wealth, populoufnefs, neat buildings, beautiful churches, of which it had once 50, but now about 30, and the induftry and civility of the inhabitants. The cathedral is a very venerable ftructure, with a curious roof, adorned with the hiftory of the Bible in little images, carved to the life, and a lofty fteeple 105 yards high. The wall of flint ftone, beautified with 40 towers and 12 gates, finifhed in 1309, is now much decayed. The city, though there is a great deal of wafte ground within the walls, was computed, upwards of 40 years ago, to contain 8000 houfes, and 50,000 inhabitants. Befides the cathedral already mentioned, the moft remarkable buildings are, the duke of Norfolk's houfe, one of the largeft in England; the caftle, which is now the county-gaol, and ftands in the heart of the city, with a deep moat round it, over which is a bridge of one very large arch; the Town-hall; the Guild-hall, formerly the church belonging to the monaftery of Black-Friars; the houfe of correction; the fhire-houfe, where the affizes are held; a lofty market-crofs, built after the manner of a piazza; the bifhop's palace; the king's fchool, founded by Edward VI. the boys to be nominated by the mayor for the time being, with the confent of the majority of aldermen. There having been formerly many thatched houfes, an order was made, that all houfes that fhould hereafter be built fhould be covered with tiles. The city is interfperfed with gardens, orchards, and trees, which make it both pleafant and healthful. It has four hofpitals, in which a great number of old men and women, boys and girls, are maintained; and a dozen charity-fchools. Here are two churches for the Dutch and French Flemings; who have particular privileges, and are very numerous. Some of the churches are thatched, and all of them crufted with flint ftone curioufly cut; which is the more wonderful, as Norwich ftands in a clay country, and has no flint within 20 miles of it. It is now governed by a mayor, recorder, fteward, two fheriffs, 24 aldermen, 60 common-council, with a town-clerk, fword-bearer, and other inferior officers. The mayor is chofen on May-day by the freemen, and fworn in on the Tuefday before Midfummer-eve. The fheriffs are alfo chofen annually, on the firft Tuefday in Auguft, one by the freemen, the other by the aldermen, and fworn in on Michaelmas-day. The freemen of the feveral wards chufe each their alderman. The common-council is chofen in Midlent. The mayor is a juftice of the peace and quorum, during his year (as are alfo the recorder and fteward) within the city and liberties; and after his mayoralty, he is a juftice during life. The trade and manufactures of the city are very confiderable. At Yarmouth they export large quantities of their manufactures, moft of which are fent to London, and import a great deal of wine, coal, fifh, oil, &c.

&c. All the city and country round are employed in the worſted manufacture, brought hither, as already obſerved, by the Flemings, in which they not only conſume the wool of their own county, in ſpinning, weaving, &c. but uſe many thouſand packs of yarn, which they receive from other parts of England, as far as Yorkſhire and Weſtmoreland. There are eight wardens of the weavers choſen annually, and ſworn to take care that there be no frauds committed in ſpinning, weaving, or dying the ſtuffs. It is computed that there are not leſs than 120,000 people employed in and about the city in the ſilk and woollen manufactures. Their markets are thought to be the greateſt in England, and furniſhed with a ſurpriſing plenty and variety of goods and proviſions. At a ſmall village to the north of the city called *St Faith's*, not leſs than 40,000 head of Scotch cattle are ſaid to be yearly bought up by the Norfolk graziers, and fattened in their meadows and marſhes. Its markets are on Wedneſday, Friday, and Saturday. It has a great number of fairs, and gives the title of earl to the duke of Norfolk.

NOSE, in anatomy; ſee there, nº 20, &c. The uſes of the noſe are, its giving us the ſenſe of ſmelling *; its ſerving in the great office of reſpiration, and in modelling voice; in receiving the abundant humours from the eyes, and in adding to the beauty of the face.

* See *Anatomy*, nº 404.

In Tartary, the greateſt beauties are thoſe who have the leaſt noſes. Ruybrock mentions the wife of the great Jenghiz Khan as a celebrated beauty, becauſe ſhe had only two holes for a noſe. In moſt other countries, China excepted, great noſes are in honour.

The Crim-Tartars break the noſes of their children while young, as thinking it a great piece of folly to have their noſes ſtand before their eyes.

NOSOLOGY, in medicine. See p. 4631—4643.

NOSTOCH, the name of a vegetable ſubſtance which ſeems to differ from moſt of the other bodies of that kind in ſeveral particulars. It is a ſubſtance of an irregular figure, of a greeniſh brown colour, and ſomewhat tranſparent. It trembles at the touch, in the manner of a jelly; but it does not melt when held in the hand. It has therefore ſomewhat of the characters of a vegetable leaf, but it has neither veins nor fibres. It is found in all ſorts of ſoils; but moſt frequently in ſandy ones, ſometimes on the gravel of garden walks, and moſt uſually makes its appearance after rain. It is found only in the ſummer-months; and retains its humidity and perfect figure as long as it is a moiſt ſeaſon, but immediately dries up and withers away on the ſun or the wind's affecting it. Many people have ſuppoſed this not to be a plant. It appears all on a ſudden, and, as it were, by a ſort of miracle, either from the earth or clouds; and ſome have called it *flower of earth*, others *flower of heaven*: and the obſcurity of its origin occaſioned its being held in great eſteem among the chemiſts; ſome of whom ſuppoſed it to contain an univerſal ſpirit, capable of converting other metals into gold. Mr Magnol and Mr Tournefort were the firſt authors who aſſerted its true origin, and ranged it among the plants. Its nature, however, was never perfectly diſcovered till Mr Reaumur took it under conſideration. He found that it was a leaf which naturally imbibed water in a very particular manner; that when it had enough of this liquor in it, it then appeared in its natural flouriſhing ſtate; and when it loſt this again, it became thin, wrinkled, and was not to be known for the ſame ſubſtance, or, indeed, ſcarce to be ſeen at all. Hence appears the reaſon of its ſuppoſed production and ſudden decay. If it has, ever ſo long, lain in the walks of a garden in its empty wrinkled ſtate, it is never taken notice of; but, on a ſhower of rain, it ſwells out into its jelly-like ſtate, and on the ſun's evaporating that moiſture it falls into its undiſtinguiſhable ſtate again; and theſe changes may affect the ſame plant alternately for many days together.

Mr Geoffroy imagined that he had found roots to the noſtoch; but Mr Reaumur poſitively aſſerts that it has none. He obſerved indeed, at certain times, on the ſurface of certain ſpecimens of this, a vaſt number of round tubercles of different ſizes, which appeared to be the ſeeds of the plant. Theſe he regularly ſowed in earthen pots of mould; and theſe produced young plants like the parent noſtoch: But even theſe were never diſcovered to have any appearance of roots; and to try farther whether they had any, Mr Reaumur turned all the plants bottom upwards, and they received no harm from it, but grew juſt as vigorouſly as before. If the noſtoch has truly no roots, as appears to be very evidently the caſe, it follows, that it imbibes its nouriſhment in the manner of ſea-plants, which imbibe the water at all their pores. It ſhould ſeem, that there are two ſpecies of this noſtoch: the one a plain, flat, leaf; the other curled, wrinkled, and variouſly undulated: and it is on this laſt that the fruits which produce the young plants are principally found. It may be, however, that the one of theſe may be the male and the other the female of the ſame ſpecies, as in many large plants; or poſſibly the being in the ſtate of fructification alone may make the difference.

NOSTRADAMUS (Michael), an able phyſician and famous aſtrologer, born at St Remy, a ſmall town, four leagues from Arles, in 1503. He ſtudied at Montpelier, and afterwards travelled to Toulouſe and Bourdeaux. At his return into Provence, he publiſhed, in 1555, his *Seven firſt prophetical centuries*. Theſe were ſo highly valued by the French king, Henry II. that he reſolved to ſee the author; and having cauſed him to be brought to him, gave him 200 golden crowns, and ſent him to ſee the princes his ſons at Blois. Charles IX. in paſſing through Provence, alſo gave him public marks of his eſteem. Noſtradamus publiſhed his three laſt Centuries in 1556; and died at Salon in 1566. He wrote other works, and after his death was collected an 11th and 12th Century from his writings. The following diſtich, attributed to Stephen Jodelle, on Noſtradamus's character, is well known.

Noſtra damus, cum falſa damus, nam fallere noſtrum eſt:
Et cum falſa damus, nil niſi Noſtra damus.

NOSTRE (Andrew le), comptroller of the buildings of the French king, and deſigner of his gardens, diſtinguiſhed himſelf by carrying the art of laying out gardens to great perfection. He was born at Paris in 1631; and was near 40 years of age when M. Fouquet ſuperintendant of the finances gave him

an opportunity of becoming known by the fine gardens of Vaux-le-Vicomte. He was afterwards employed by Lewis XIV. at Verfailles, Trianon, St Germains, &c. and difcovered an admirable tafte in all his works. In 1678 he went to Rome, with the permiffion of the French king, to improve his fkill; but he found nothing there comparable to what he himfelf had done. Pope Innocent XI. refolved to fee Le Noftre, and gave him a pretty long audience; at the conclufion of which Le Noftre faid, "I have feen the two greateft men in the world; your holinefs, and the king my mafter." There is a great difference, anfwered the pope: "The king is a great victorious prince; and I am a poor prieft, the fervant of the fervants of God." Le Noftre, charmed with this anfwer, and forgetting who he was with, clapped the pope on the fhoulder, faying, "Reverend father, you look extremely well, and will live to bury all the facred college." The pope laughed at his prediction. Le Noftre, charmed more and more at the goodnefs of the fovereign pontiff, and the fingular efteem he fhewed for the king, threw his arms about the pope's neck and kiffed him. It was his cuftom to behave in the fame manner to all who fpoke in praife of Lewis XIV. and he even embraced the king himfelf whenever that prince returned from the country. Le Noftre had alfo a talent for painting. He preferved his good fenfe and vivacity of mind to the end of his life; and died at Paris in 1700, aged 87.

NOTARY, (NOTARIUS), fignifies a perfon, ufually fome fcrivener, who takes notes, or frames fhort draughts, of contracts, obligations, charter-parties, or other writings. At prefent we call him a *notary-public*, who publicly attefts deeds, or writings, in order to make them authentic in another nation: but he is principally employed in bufinefs concerning merchants; as making protefts of bills of exchange, &c. And noting a bill, is where he goes to take notice of a merchant's refufal to accept or pay the fame.

NOTATION, in arithmetic and algebra, the method of expreffing numbers or quantities by figns or characters appropriated for that purpofe. See ARITHMETIC and ALGEBRA.

NOTES, in mufic, characters which mark the founds, *i. e.* the elevations and fallings of the voice, and the fwiftnefs and flownefs of its motions.

NOTE is likewife ufed for a mark made in a book or writing, where there occurs fomething remarkable and worthy of particular notice: as alfo for an obfervation or explication of fome paffage in an author added in the margin, at the bottom of the page, or elfewhere; in which fenfe it ftands contradiftinguifhed to *text*.

NOTE, is alfo a minute, or fhort writing, containing fome article of bufinefs; in which fenfe we fay, promiffory note, note of hand, bank-note, &c.

NOTHUS, fignifies *fpurious*, or *baftard;* whence it is figuratively applied by phyficians to fuch difeafes as, though in a refpect of a fimilitude of fymptoms, &c. they have the fame denomination as fome others, yet are of a different origin, feat, or the like, from the fame.

NOTION, in logic, an idea or reprefentation of any thing in the mind. See LOGIC and METAPHYSICS.

NOTITIA, in literary hiftory, a book that gives an account of a particular country, city, or other place: fuch is the *Notitia Imperii Romani*, *Notitia Romæ Antiquæ*, &c.

NOTO, an ancient, large, and handfome town of Sicily, and capital of the Val-di-Noto. It was entirely ruined by an earthquake in 1693; but the inhabitants built another town at fome diftance from it, which they call *Noto Nuovo*. E. Long. 14. 0. N. Lat. 36. 50.

NOTO (*Val-di*), one of the three valleys or provinces into which Sicily is divided; and it lies between the fea, Val-di-Demona, and Val-di-Mazara. Noto is the capital town.

NOTONECTA, the BOAT-FLY; a genus of infects belonging to the order of hemiptera. It generally inhabits the water, and alway fwims on its back, and is very fwift in its motions. Its belly, which it fhews while in the water, is of a yellowifh white; its legs are long; when taken out of the water, it hops. It is indeed a very beautiful and very nimble little creature; and is common in the ponds of water in Hyde-park, and in feveral other places about London. It has four wings, fix legs, and no antennæ; it is eight inches long, three broad, and two and a half thick. The body is black, and of a very particular form, being flattifh at the belly, and rifing to a ridge on the middle of the back; fo that when it fwims, which is almoft always on the back, its body refmbles a boat in figure.

The belly is jointed, ftriated, and hairy; and has a large opening at the tail, out of which, when hurt, it thrufts forth fomething refembling a fting. The head and fhoulders are large, hard, and yellow, without any fpots; the eyes are large and red, and of a fomewhat triangular form. The nofe is a long, green, hollow probofcis, terminating in a hard and fharp brown point; this, in its natural pofture, is kept under the belly, and reaches to the middle pair of legs. The outer pair of wings are of a pale flefh-colour, with fpots of a dead white; thefe are long, narrow, and fomewhat tranfparent: they terminate in a roundifh point, and perfectly cover the whole body. The triangular piece which ftands between the top of the wings is hard, and perfectly black; the inner wings are broader and fhorter than the outer ones; they are thin and perfectly tranfparent, and are of a pale pearl colour. The legs are green and hairy; the foremoft pair are fhorteft; the middle ones longer than thefe; but the hinder pair are greatly longer than all the reft, fo that they ferve as oars, and are tufted with hair at the end to that purpofe. This creature moftly lives in the water, where it preys on fmall infects, killing them and fucking their juices with its probofcis, in the manner of the water-fcorpion and many other aquatic infects; and it feizes its prey violently, and darts with incredible fwiftnefs to a confiderable diftance after it.

Though it generally lives in the water, it fometimes, however, crawls out in good weather; and drying its wings by expanding them in the fun, takes flight, and becomes an inhabitant of the air, not to be known for the fame creature, unlefs to thofe who had accurately obferved it before; when tired of flying, or in danger of an enemy, it immediately plunges into the water. If taken into the hand, it ftings, and

Notteberg, Nottingharnshire. gives an intolerable pain, but this goes off in a very few minutes. This is the ſpecies moſt frequently met with; but it is not the only *notonecta* we have, three or four other kinds, different in ſize and colour, being found not unfrequently in large waters.

NOTTEBURG, a town of Ruſſia, in the province of Ingria, ſeated on an iſland in the lake Ladoga, at the place where the river Nieva proceeds from this lake. It is ſtrong, has a good citadel, and was capital of the province before Peterſburg was built. E. Long. 31. 40. N. Lat. 60. 0.

NOTTINGHAMSHIRE, a county of England, bounded on the eaſt by Lincolnſhire, on the ſouth-eaſt and ſouth by Leiceſterſhire, on the weſt by Derbyſhire, and on the north and north-weſt by Yorkſhire. It extends in length 43 miles, 24 in breadth, and 110 miles in compaſs; containing 560,000 acres, 8 hundreds, 9 market-town, 168 pariſhes, 450 villages, about 17500 houſes, and 95000 inhabitants. No county in England enjoys a pleaſanter and healthier air. As for the ſoil, it differs widely in different parts of the county. Towards the weſt, where lies the foreſt of Sherwood, it is ſandy; and therefore that part of the county is called by the inhabitants, the *Sand:* but the ſouth and eaſt parts, watered by the Trent and the rivulets that fall into it, are clayey; and for that reaſon are called by the inhabitants, the *Clay*. The latter is fruitful both in corn and paſture; but the former produces little beſides wood, coal, and ſome lead. The county has a variety of commodities and manufactures, as wool, leather, tallow, butter, cheeſe, coal, marle, cattle, malt, liquorice, ſtockings, glaſs, earthen-wares, and ſtrong ale. The principal rivers are the Trent and Idle. The Trent, whoſe name is ſuppoſed to be derived from the French or Latin word ſignifying *thirty*, either becauſe it receives thirty ſmaller rivers, or has thirty different ſorts of fiſh in it, is inferior to no river in England, but the Severn, Thames, and Humber. It enters the county on the ſouth-weſt, and paſſes through it to the north-eaſt, where it enters Lincolnſhire, and after a long courſe falls at laſt into the Humber. The Idle riſes in Sherwood-foreſt; and after traverſing the northern part of the county, falls into the Trent upon the borders of Yorkſhire and Lincolnſhire.

The ſpacious foreſt of Sherwood lies in the weſt part of the county, and indeed takes up the greateſt part of it. It was formerly ſo thick, that it was hardly paſſable; but now it is much thinner. It feeds an infinite number of deer and ſtags; and has ſome towns in it, of which Mansfield is the chief. It abounds in coal, and a road lies through it for thirty miles together. Since the reign of king Edward I. the nobility and gentry have had grants of it. It is governed by a great number of officers under the earl of Cheſterfield, chief foreſter; whoſe anceſtor, Sir John Stanhope, had a grant of it, with liberty to deſtroy and kill at pleaſure, reſerving only an hundred deer in the whole walk. The principal town is

NOTTINGHAM, which gives name to the county. It is a handſome town, and a county of itſelf by charter. The name is derived from the Saxon word *Snottengham*, which ſignifies caves, from the caves and apartments anciently dug in the rocks on which the town ſtands. Theſe, being ſoft, eaſily yield to the ſpade and pickaxe; whence the townſmen have excellent cellars for the vaſt quantities of malt liquors made here, and ſent, as well as their malt, to moſt parts of England. The ſituation of the town is very pleaſant, having meadows on one hand, and hills of a gentle, eaſy aſcent, on the other. It is well ſupplied with fuel, both wood and coal, from the foreſt; and with fiſh by the Trent, which runs about a mile to the ſouth of it, and has been made navigable for barges: ſo that they receive by it not only great quantities of cheeſe from Warwickſhire and Staffordſhire; but all their heavy goods from the Humber, and even from Hull. It is of great antiquity; and had anciently a very ſtrong caſtle, where is now a fine ſeat belonging to the duke of Newcaſtle. It is noted for its horſe-races on a fine courſe on the north ſide of the town. The corporation is governed by a mayor, recorder, ſix aldermen, two coroners, two ſheriffs, two chamberlains, and twenty-four common-council men, eighteen of the ſenior-council, and ſix of the junior, a bell-bearer, and two pinders, one for the fields, and the other for the meadows. The town being within the juriſdiction of the foreſt, the former of theſe pindars is town-woodward, and attends the foreſt courts. It has three neat churches, the chief of which is St Mary's; and an alm-houſe, endowed with 100 l. a-year, for twelve poor people; with a noble town-houſe, ſurrounded with piazzas. A conſiderable trade is carried on in glaſs and earthen-wares, and frame-ſtockings, beſides the malt, and malt-liquors, mentioned above. Marſhal Tallard, when a priſoner in England, was confined to this town and county. In the duke of Newcaſtle's park there is a ledge of rocks hewn into a church, houſes, chambers, dove-houſes, &c. The altar of the church is natural rock, and between that and the caſtle there is an hermitage of the like workmanſhip. Upon the ſide of a hill there is a very extraordinary ſort of a houſe, where you enter at the garret, and aſcend to the cellar, which is at the top of the houſe. Here is a noted hoſpital founded by John Plumtree, Eſq; in the reign of Richard II. for thirteen poor old widows. There are four handſome bridges over the Trent and Lind. To keep theſe in repair, and other uſes, the corporation has good eſtates. This town and Winchelſea both give title of earl to the noble family of Finch. Here David, king of Scots, when a priſoner in England, reſided; and under-ground in a vault, called *Mortimer's hole*, becauſe Roger Mortimer, earl of March, is ſaid to have abſconded in it, when he was taken and hanged by order of Edward III.

Nottingham. Nova.

NOVA-SCOTIA. See *Nova*-SCOTIA.

NOVA *Zembla*. See *Nova* ZEMBLA.

NOVALLE, a ſmall, rich, and populous town of Italy, between Padus and Treviſo. E. Long. 12. 5. N. Lat. 45. 35.

NOVARA, an ancient, well built, and ſtrong town of Italy, in the duchy of Milan, and capital of the Novareſe, with a biſhop's ſee; ſeated upon an eminence. E. Long. 8. 35. N. Lat. 45. 25.

NOVATIANS, a Chriſtian ſect which ſprung up in the third century, ſo called from Novatian a prieſt of Rome, or Novatus. See NOVATUS.

NOVATION, or INNOVATION, in the civil law, denotes the change of one kind of obligation for another;

ther; as when a promife is accepted inftead of a written obligation.

NOVATUS, a prieft of Carthage, in the third century, who, to avoid being punifhed for a crime, jonied with the deacon, named *Feliciffimus*, againft St Cyprian. He went to Rome in 251; and there found Novatian, a prieft who had acquired great reputation by his eloquence; but who murmured at his not being raifed to the fee of Rome in preference to pope Cornelius. Novatus contracted a friendfhip with him; and afterwards, it is faid, getting three ignorant bifhops, made them drunk, and then obliged them to ordain Novatian bifhop of Rome. This irregular ordination produced a very great fchifm; both Novatus and Novatian maintained, that the church had not the power to receive thofe to communion who were fallen into idolatry. There are attributed to Novatian, the treatife on the Trinity, and the book on Jewifh meats, which are among Tertullian's works; and it was he, and not Novatus, who gave his name to the fect called *Novatians*.

NOVEL, in matters of literature, a fictitious hiftory of a feries of entertaining events in common life, wherein the rules of probability are, or ought to be, ftrictly preferved.

Novel, in the civil law, a term ufed for the conftitutions of feveral emperors, more particularly thofe of Juftinian. They were called *novels*, either from their producing a great alteration in the face of the ancient law, or becaufe they were made on new cafes, and after the revifal of the ancient code.

NOVELTY, or Newness. Of all the circumftances that raife emotions, not excepting beauty, nor even greatnefs, fays Lord Kames †, novelty hath the moft powerful influence. A new object produceth inftantaneoufly an emotion termed *wonder*, which totally occupies the mind, and for a time excludes all other objects. Converfation among the vulgar never is more interefting than when it turns upon ftrange objects and extraordinary events. Men tear themfelves from their native country in fearch of things rare and new; and novelty converts into a pleafure, the fatigues and even perils of travelling. To what caufe fhall we afcribe thefe fingular appearances? To curiofity undoubtedly; a principle implanted in human nature for a purpofe extremely beneficial, that of acquiring knowledge; and the emotion of wonder raifed by new and ftrange objects, inflames our curiofity to know more of fuch objects. This emotion is different from *admiration:* novelty, wherever found, whether in a quality or action, is the caufe of wonder; admiration is directed to the perfon who performs any thing wonderful.

† *Elem. of Criticifm.*

During infancy, every new object is probably the occafion of wonder, in fome degree; becaufe, during infancy, every object at firft fight is ftrange as well as new: but as objects are rendered familiar by cuftom, we ceafe by degrees to wonder at new appearances, if they have any refemblance to what we are acquainted with; for a thing muft be fingular as well as new, to raife our wonder. To fave multiplying words, we would be underftood to comprehend both circumftances when we hereafter talk of novelty.

In an ordinary train of perceptions where one thing introduces another, not a fingle object makes its appearance unexpectedly †: the mind thus prepared for the reception of its objects, admits them one after another without perturbation. But when a thing breaks in unexpectedly, and without the preparation of any connection, it raifes an emotion, known by the name of *furprife*. That emotion may be produced by the moft familiar object, as when one unexpectedly meets a friend who was reported to be dead; or a man in high life, lately a beggar. On the other hand, a new object, however ftrange, will not produce the emotion, if the fpectator be prepared for the fight: an elephant in India will not furprife a traveller who goes to fee one; and yet its novelty will raife his wonder: an Indian in Britain would be much furprifed to ftumble upon an elephant feeding at large in the open fields; but the creature itfelf, to which he was accuftomed, would not raife his wonder.

† See the article Perceptions.

Surprife thus in feveral refpects differs from wonder: unexpectednefs is the caufe of the former emotion; novelty is the caufe of the latter. Nor differ they lefs in their nature and circumftances, as will be explained by and by. With relation to one circumftance they perfectly agree; which is, the fhortnefs of their duration: the inftantaneous production of thefe emotions in perfection, may contribute to that effect, in conformity to a general law, That things foon decay which foon come to perfection: the violence of the emotions may alfo contribute; for an ardent emotion, which is not fufceptible of increafe, cannot have a long courfe. But their fhort duration is occafioned chiefly by that of their caufes: we are foon reconciled to an object, however unexpected; and novelty foon degenerates into familiarity.

Whether thefe emotions be pleafant or painful, is not a clear point. It may appear ftrange, that our own feelings and their capital qualities, fhould afford any matter for a doubt: but when we are engroffed by any emotion, there is no place for fpeculation; and when fufficiently calm for fpeculation, it is not eafy to recal the emotion with accuracy. New objects are fometimes terrible, fometimes delightful: the terror which a tyger infpires is greateft at firft, and wears off gradually by familiarity: on the other hand, even women will acknowledge that it is novelty which pleafes the moft in a new fafhion. It would be rafh however to conclude, that wonder is itfelf neither pleafant nor painful, but that it affumes either quality according to circumftances. An object, it is true, that hath a threatening appearance, adds to our terror by its novelty: but from that experiment it doth not follow, that novelty is in itfelf difagreeable; for it is perfectly confiftent, that we be delighted with an object in one view, and terrified with it in another. A river in flood fwelling over its banks, is a grand and delightful object; and yet it may produce no fmall degree of fear when we attempt to crofs it: courage and magnanimity are agreeable; and yet, when we view thefe qualities in an enemy, they ferve to increafe our terror. In the fame manner, novelty may produce two effects clearly diftinguifhable from each other: it may, directly and in itfelf, be agreeable; and it may have an oppofite effect indirectly, which is, to infpire terror; for when a new object appears in any degree danger-

ous,

Novelty.

ous, our ignorance of its powers and faculties affords ample fcope for the imagination to drefs it in the moft frightful colours. The firft fight of a lion, for example, may at the fame inftant produce two oppofite feelings, the pleafant emotion of wonder, and the painful paffion of terror: the novelty of the object produces the former directly, and contributes to the latter indirectly. Thus when the fubject is analifed, we find, that the power which novelty hath indirectly to inflame terror, is perfectly confiftent with its being in every circumftance agreeable. The matter may be put in the cleareft light, by adding the following circumftances. If a lion be firft feen from a place of fafety, the fpectacle is altogether agreeable without the leaft mixture of terror. If, again, the firft fight puts us within reach of that dangerous animal, our terror may be fo great as quite to exclude any fenfe of novelty. But this fact proves not that wonder is painful: it proves only, that wonder may be excluded by a more powerful paffion. Every man may be made certain from his own experience, that wonder raifed by a new object that is inoffenfive, is always pleafant; and with refpect to offenfive objects, it appears, from the foregoing deduction, that the fame muft hold as long as the fpectator can attend to the novelty.

Whether furprife be in itfelf pleafant and painful, is a queftion not lefs intricate than the former. It is certain that furprife inflames our joy when unexpectedly we meet with an old friend; and not lefs our terror when we ftumble upon any thing noxious. To clear that queftion, the firft thing to be remarked is, that in fome inftances an unexpected object overpowers the mind, fo as to produce a momentary ftupefaction: where the object is dangerous, or appears fo, the fudden alarm it gives, without preparation, is apt totally to unhinge the mind, and for a moment to fufpend all its faculties, even thought itfelf; in which ftate a man is quite helplefs; and if he move at all, is as like to run upon the danger as from it. Surprife carried to fuch a height, cannot be either pleafant or painful; becaufe the mind, during fuch momentary ftupefaction, is in a good meafure, if not totally, infenfible.

If we then inquire for the character of this emotion, it muft be where the unexpected object or event produceth lefs violent effects. And while the mind remains fenfible of pleafure and pain, is it not natural to fuppofe, that furprife, like wonder, fhould have an invariable character? It would appear, however, that furprife has no invariable character, but affumes that of the object which raifes it. Wonder being an emotion invariably raifed by novelty, and being diftinguifhable from all other emotions, ought naturally to poffefs one conftant character. The unexpected appearance of an object, feems not equally intitled to produce an emotion diftinguifhable from the emotion, pleafant or painful, that is produced by the object in its ordinary appearance: the effect it ought naturally to have, is only to fwell that emotion, by making it more pleafant or more painful than it commonly is. And that conjecture is confirmed by experience, as well as by language which is built upon experience: when a man meets a friend unexpectedly, he is faid to be agreeably furprifed; and when he meets an enemy unexpectedly, he is faid to be difagreeably furprifed. It appears, then, that the fole effect of furprife is to fwell the emotion raifed by the object. And that effect can be clearly explained: a tide of connected perceptions glide gently into the mind, and produce no perturbation; but an object breaking in unexpectedly, founds an alarm, roufes the mind out of its calm ftate, and directs its whole attention to the object, which, if agreeable, becomes doubly fo. Several circumftances concur to produce that effect: on the one hand, the agitation of the mind and its keen attention, prepare it in the moft effectual manner for receiving a deep impreffion: on the other hand, the object, by its fudden and unforefeen appearance, makes an impreffion, not gradually as expected objects do, but as at one ftroke with its whole force. The circumftances are precifely fimilar where the object is in itfelf difagreeable (A).

The pleafure of novelty is eafily diftinguifhed from that of variety: to produce the latter, a plurality of objects is neceffary; the former arifes from a circumftance found in a fingle object. Again, where objects, whether coexiftent or in fucceffion, are fufficiently diverfified, the pleafure of variety is complete, though every fingle object of the train be familiar; but the pleafure of novelty, directly oppofite to familiarity, requires no diverfification.

There are different degrees of novelty, and its effects are in proportion. The loweft degree is found in objects furveyed a fecond time after a long interval; and that in this cafe an object takes on fome appear-

(A) What the Marefchal Saxe terms *le cœur humain*, is no other than fear occafioned by furprife. It is owing to that caufe that an ambufh is generally fo deftructive: intelligence of it beforehand renders it perfectly harmlefs. The Marefchal gives from Cæfar's Commentaries two examples of what he calls *le cœur humain*. At the fiege of Amiens by the Gauls, Cæfar came up with his army, which did not exceed 7000 men; and began to intrench himfelf in fuch hurry, that the barbarians, judging him to be afraid, attacked his intrenchments with great fpirit. During the time they were filling up the ditch, he iffued out with his cohorts, and by attacking them unexpectedly ftruck a panic that made them fly with precipitation, not a fingle man offering to make a ftand. At the fiege of Alefia, the Gauls infinitely fuperior in number attacked the Roman lines of circumvallation, in order to raife the fiege. Cæfar ordered a body of his men to march out filently, and to attack them on the one flank, while he with another body did the fame on the other flank. The furprife of being attacked when they expected a defence only, put the Gauls into diforder, and gave an eafy victory to Cæfar.

A third may be added not lefs memorable. In the year 846, an obftinate battle was fought between Xamire king of Leon, and Abdoulrahman the Moorifh king of Spain. After a very long conflict, the night only prevented the Arabians from obtaining a complete victory. The king of Leon, taking advantage of the darknefs, retreated to a neighbouring hill, leaving the Arabians mafters of the field of battle. Next morning, perceiving that he could not maintain his place for want of provifions, nor be able to draw off his men in the face of a victorious army, he ranged his men in order of battle, and, without lofing a moment, marched to attack the enemy, refolving to conquer or die. The Arabians, aftonifhed to be attacked by thofe who were conquered the night before, loft all heart: fear fucceeded to aftonifhment, the panic was univerfal, and they all turned their backs without almoft drawing a fword.

ance of novelty, is certain from experience: a large building of many parts variouſly adorned, or an extenſive field embelliſhed with trees, lakes, temples, ſtatues, and other ornaments, will appear new oftener than once: the memory of an object ſo complex is ſoon loſt, of its parts at leaſt, or of their arrangement. But experience teaches, that, even without any decay of remembrance, abſence alone will give an air of novelty to a once familiar object; which is not ſurpriſing, becauſe familiarity wears off gradually by abſence: thus a perſon with whom we have been intimate, returning after a long interval, appears like a new acquaintance. And diſtance of place contributes to this appearance, not leſs than diſtance of time: a friend, for example, after a ſhort abſence in a remote country, has the ſame air of novelty as if he had returned after a longer interval from a place nearer home: the mind forms a connection between him and the remote country, and beſtows upon him the ſingularity of the objects he has ſeen. For the ſame reaſon, when two things equally new and ſingular are preſented, the ſpectator balances between them; but when told that one of them is the product of a diſtant quarter of the world, he no longer heſitates, but clings to it as the more ſingular: hence the preference given to foreign luxuries, and to foreign curioſities, which appear rare in proportion to their original diſtance.

The next degree of novelty, mounting upward, is found in objects of which we have ſome information at ſecond hand; for deſcription, though it contribute to familiarity, cannot altogether remove the appearance of novelty when the object itſelf is preſented: the firſt ſight of a lion occaſions ſome wonder, after a thorough acquaintance with the correcteſt pictures and ſtatues of that animal.

A new object that bears ſome diſtant reſemblance to a known ſpecies, is an inſtance of a third degree of novelty: a ſtrong reſemblance among individuals of the ſame ſpecies, prevents almoſt entirely the effect of novelty, unleſs diſtance of place or ſome other circumſtance concur; but where the reſemblance is faint, ſome degree of wonder is felt, and the emotion riſes in proportion to the faintneſs of the reſemblance.

The higheſt degree of wonder ariſeth from unknown objects that have no analogy to any ſpecies we are acquainted with. Shakeſpeare in a ſimile introduces that ſpecies of novelty:

> As glorious to the ſight
> As is a winged meſſenger from heaven
> Unto the white up-turned wond'ring eye
> Of mortals, that fall back to gaze on him
> When he beſtrides the lazy-pacing clouds
> And ſails upon the boſom of the air.
>
> *Romeo and Juliet.*

One example of that ſpecies of novelty deſerves peculiar attention; and that is, when an object altogether new is ſeen by one perſon only, and but once. Theſe circumſtances heighten remarkably the emotion: the ſingularity of the ſpectator concurs with the ſingularity of the object, to inflame wonder to its higheſt pitch.

In explaining the effects of novelty, the place a being occupies in the ſcale of exiſtence, is a circumſtance that muſt not be omitted. Novelty in the individuals of a low claſs is perceived with indifference, or with a very ſlight emotion: thus a pebble, however ſingular in its appearance, ſcarce moves our wonder. The emotion riſes with the rank of the object; and, other circumſtances being equal, is ſtrongeſt in the higheſt order of exiſtence; a ſtrange inſect affects us more than a ſtrange vegetable; and a ſtrange quadruped more than a ſtrange inſect.

However natural novelty may be, it is a matter of experience, that thoſe who reliſh it the moſt are careful to conceal its influence. Love of novelty, it is true, prevails in children, in idlers, and in men of ſhallow underſtanding: and yet, after all, why ſhould one be aſhamed of indulging a natural propenſity? A diſtinction will afford a ſatisfactory anſwer. No man is aſhamed of curioſity when it is indulged to acquire knowledge. But to prefer any thing merely becauſe it is new, ſhows a mean taſte which one ought to be aſhamed of: vanity is commonly at the bottom, which leads thoſe who are deficient in taſte to prefer things odd, rare, or ſingular, in order to diſtinguiſh themſelves from others. And in fact, that appetite, as abovementioned, reigns chiefly among perſons of a mean taſte, who are ignorant of refined and elegant pleaſures.

One final cauſe of wonder, hinted above, is, that this emotion is intended to ſtimulate our curioſity. Another, ſomewhat different, is, to prepare the mind for receiving deep impreſſions of new objects. An acquaintance with the various things that may affect us, and with their properties, is eſſential to our well-being: nor will a ſlight or ſuperficial acquaintance be ſufficient; they ought to be ſo deeply engraved on the mind, as to be ready for uſe upon every occaſion. Now, in order to a deep impreſſion, it is wiſely contrived, that things ſhould be introduced to our acquaintance with a certain pomp and ſolemnity productive of a vivid emotion. When the impreſſion is once fairly made, the emotion of novelty being no longer neceſſary, vaniſheth almoſt inſtantaneouſly; never to return, unleſs where the impreſſion happens to be obliterated by length of time or other means, in which caſe the ſecond introduction hath nearly the ſame ſolemnity with the firſt.

Deſigning wiſdom is no where more eligible than in this part of the human frame. If new objects did not affect us in a very peculiar manner, their impreſſions would be ſo ſlight as ſcarce to be of any uſe in life: on the other hand, did objects continue to affect us as deeply as at firſt, the mind would be totally engroſſed with them, and have no room left either for action or reflection.

The final cauſe of ſurpriſe is ſtill more evident than of novelty. Self-love makes us vigilantly attentive to ſelf-preſervation; but ſelf-love, which operates by means of reaſon and reflection, and impels not the mind to any particular object or from it, is a principle too cool for a ſudden emergency; an object breaking in unexpectedly, affords no time for deliberation; and in that caſe, the agitation of ſurpriſe comes in ſeaſonably to rouſe ſelf-love into action: ſurpriſe gives the alarm; and if there be any appearance of danger, our whole force is inſtantly ſummoned to ſhun or to prevent it.

NOVELLARA, a handſome town of Italy, and capital of a ſmall diſtrict of the ſame name, with a handſome caſtle, where their ſovereign reſides. E. Lon. 10.

Novemviri || Noviodunum.

10. 37. N. Lat. 45. 50.

NOVEMVIRI, nine magiftrates of Athens, whofe government lafted but for one year. The firft of whom was called *archon*, or prince; the fecond *bafilius*, or king; the third *polemarchus*, or general of the army: the other fix were called *thefmothetæ*, or lawgivers. They took an oath to obferve the laws; and in cafe of failure, obliged themfelves to beftow upon the commonwealth a ftatue of gold as big as themfelves. Thofe who difcharged their office with honour, were received into the number of the fenators of Areopagus.

NOVI, a town of Italy, in the territory of Genoa, on the confines of the Milanefe. It was taken by the Piedmontefe in 1746. E. Long. 8. 48. N. Lat. 44. 45.

Novi-*Bazar*, a confiderable town of Turkey in Europe, and in Servia, near the river Orefco. E. Long. 20. 24. N. Lat. 43. 25.

NOVIGRAD, a fmall but ftrong town of Upper Hungary, capital of a county of the fame name, with a good caftle, feated on a mountain near the Danube. E. Long. 18. 10. N. Lat. 47. 50.

Novigrad, a fmall but ftrong town of Dalmatia, with a caftle, and fubject to the Turks; feated on a lake of the fame name, near the gulph of Venice. E. Long. 16. 45. N. Lat. 44. 30.

Novigrad, a very ftrong place of Servia, fubject to the Turks; feated near the Danube. E. Long. 26. 5. N. Lat. 45. 5.

NOVICE, a perfon not yet fkilled or experienced in an art or profeffion.

In the ancient Roman militia, *novicii*, or *novitii*, were the young raw foldiers, diftinguifhed by this appellation from the veterans.

In the ancient orders of knighthood, there were novices, or clerks in arms, who went through a kind of apprenticefhip ere they were admitted knights. See Knight.

Novice is more particularly ufed in monafteries for a religious yet in his, or her, year of probation, and who has not made the vows.

In fome convents, the fub-prior has the direction of the novices. In nunneries, the novices wear a white veil; the reft a black one.

NOVICIATE, a year of probation appointed for the trial of religious, whether or no they have a vocation, and the neceffary qualities for living up to the rule; the obfervation whereof they are to bind themfelves to by vow. The noviciate lafts a year at leaft; in fome houfes more. It is efteemed the bed of the civil death of a novice, who expires to the world by profeffion.

NOVIODUNUM (Cæfar), a town of the Ædui, commodioufly feated on the Liguris: the *Nivernum* of Antonine. Now *Nevers* in the Orleanois, on the Loire.—A fecond *Noviodunum* of the Aulerci Diablintes, in Gallia Celtica, (Antonine); called *Noviodunum*, (Ptolemy), and *Noningentum Rotrudum* by the moderns: *Nogente le Rotrou*, capital of the duchy of Perche.—A third, of the Bituriges. (Cæfar): Now *Nueve fur Baranion*; a village 15 miles to the north of Bourges, towards Orleans.—A fourth, of Mœfia Inferior, (Ptolemy), fituate on the Ifter: now *Nivorz*, in Beffarabia.—A fifth, of Pannonia Superior, (Antonine); now *Gurkfeld* in Carinthia.—A fixth *Noviodunum Sueffionum*, the fame with *Augufta Sueffionum*. —A feventh, *Noviodunum* of the Veromandui in Gallia Belgica, (Cæfar): now *Noyon* in the Ifle of France, on the borders of Picardy.

Novogorod || Nubecula.

NOVOGOROD welicki, or *Great Novogorod*, a rich and very large town of the Ruffian empire, and capital of a duchy of the fame name, with an archbifhop's fee, and a caftle where the archbifhop and the waiwode refide. It is commonly called the *grand magazine*, becaufe hither they bring their rich merchandifes that come from the Levant. It contains 180 churches and monafteries, and carries on a great trade in Ruffia leather. It is feated on the river Wolcoff, near the lake Honen. E. Long. 33. 40. N. Lat. 58. 23.

Novogorod *Welicki*, a province of Mofcow, bounded on the north by Ingria; on the eaft by part of the duchy of Belozero, and that of Tuera, which alfo bounds it on the fouth, with the province of Rzeva; and on the weft by Plefcow. It is full of lakes and forefts; however, there are fome places which produce corn, flax, hemp, honey, and wax.

Novogorod *Serpfkoi*, a ftrong town of the Ruffian empire, and capital of a province of Siberia of the fame name, feated on the river Dubica, in E. Long. 33. 20. N. Lat 52. 30.

NOVOGORODECK, a town of Lithuania, and capital of a palatinate of the fame name. It is a large town, and fituated in a vaft plain, in E. Long. 25. 30. N. Lat. 53. 45.

NOURISHMENT. See Nutrition.

Nourishment *of Vegetables*. See Agriculture, Part I. Sect. 1. and 2. and Plants; alfo the article Composts.

NOWED, in heraldry, fignifies "knotted," from the Latin *nodatus*; being applied to the tails of fuch creatures as are very long, and fometimes reprefented in coat-armour as tied up in a knot.

NUAYHAS, the Ague-tree; a name given by the Indians to a fort of Bamboo-cane, the leaves of which falling into the water, are faid to impregnate it with fuch virtue, that the bathing in it afterwards will cure the ague. They ufe alfo a decoction of the leaves to diffolve coagulated blood, giving it internally, and at the fame time rubbing the bruifed part externally with it. It is faid that this plant bears its flowers only once in its life; that it lives 60 years before thefe make their appearance; but that when they begin to fhew themfelves, it withers away in about a month afterwards; that is, as foon as it has ripened the feed. There feems to be fomething of fiction in the account of many other particulars relating to this tree in the *Hortus Malabaricus*; but it feems certain, that the length of the ftalks, or trunk, muft be very great: for, in the gallery of Leyden, there is preferved a cane of it 28 feet long; and another not much fhorter in the Afhmolean mufeum at Oxford, and which is more than eight inches in diameter: yet both thefe appear to be only parts of the whole trunk, they being nearly as large at one end as at the other.

NUBECULA, little cloud, in medicine, a term fometimes ufed for difeafe in the eye, wherein objects appear as through a cloud or mift.

The

The nubecula feems to arife from certain grofs particles detained in the pores of the cornea, or fwimming in the aqueous humour, and thus intercepting the rays of light.

Nubecula, or *Nubes*, is alfo ufed for what we otherwife call *albugo*. See Albugo.

Nubecula is alfo ufed for a matter in form of a cloud, fufpended in the middle of the urine.

NUBIA, a country of Africa, bounded on the north by Egypt, on the fouth by Abyffinia, on the eaft by the coaft of Abefh or Abex, and on the weft by Zaara and Nigritia. It is faid to be 400 leagues in length, and 200 in breadth, and to be watered by a river which falls into the Nile; but of thefe dimenfions we have little certainty, and nothing can be depended upon concerning the nature of the country or its inhabitants.

NUCLEUS, in general, denotes the kernel of a nut, or even any feed inclofed within a hufk. The term *nucleus* is alfo ufed for the body of a comet, otherwife called its *head*.

NUDITIES, in painting and fculpture, thofe parts of an human figure which are not covered with any drapery; or thofe parts where the carnation appears.

NULLITY, in law, fignifies any thing that is null or void: thus there is a nullity of marriage, where perfons marry within the degrees, or where infants marry without confent of their parents or guardians.

NUMANTIA, a very noble city, the ornament of the Hither Spain, (Florus); as appears from the Numantine war; and though deftroyed by the Romans under Scipio Æmilianus, it was afterwards no doubt reftored, becaufe mentioned not only by Ptolemy, but alfo by Antonine, who determines its fituation between Uxama and Turiafo; and Strabo fays, the Durius run by it, while ftill recent and near its fource. With 4000 men it held out a fiege of 14 years, againft 40,000 Romans. And all this it did, like another Sparta, without walls and without turrets; but this is doubtfully mentioned by authors.—*Numantini*, the people; who, after a tedious and clofe fiege, and after ftruggling long with famine, at length deftroyed themfelves and their city by fire.

NUMBER, an affemblage of feveral units, or things of the fame kind. See Arithmetic; and Metaphysics, n° 62—65.

Number, fays Malcolm, is either abftract or applicate: Abftract, when referred to things in general, without attending to their particular properties; and applicate, when confidered as the number of a particular fort of things, as yards, trees, or the like.

When particular things are mentioned, there is always fomething more confidered than barely their numbers; fo that what is true of numbers in the abftract, or when nothing but the number of things is confidered, will not be true when the queftion is limited to particular things: for inftance, the number two is lefs than three; yet two yards is a greater quantity than three inches: and the reafon is, becaufe regard muft be had to their different natures as well as number, whenever things of a different fpecies are confidered; for though we can compare the number of fuch things abftractedly, yet we cannot compare them in any applicate fenfe. And this difference is neceffary to be confidered, becaufe upon it the true fenfe, and the poffibility or impoffibility, of fome queftions depend.

Number is unlimited in refpect of increafe; becaufe we can never conceive a number fo great, but ftill there is a greater. However, in refpect of decreafe, it is limited; unity being the firft and leaft number, below which therefore it cannot defcend.

Kinds and Diftinctions of Numbers. Mathematicians, confidering number under a great many relations, have eftablifhed the following diftinctions.

Broken numbers are the fame with fractions.

Cardinal numbers are thofe which exprefs the quantity of units, as 1, 2, 3, 4, *&c.* whereas ordinal numbers are thofe which exprefs order, as 1ft, 2d, 3d, *&c.*

Compound number, one divifible by fome other number befides unity; as 12, which is divifible by 2, 3, 4, and 6. Numbers, as 12 and 15, which have fome common meafure befides unity, are faid to be compound numbers among themfelves.

Cubic number is the product of a fquare number by its root: fuch is 27, as being the product of the fquare number 9, by its root 3. All cubic numbers, whofe root is lefs than 6, being divided by 6, the remainder is the root itfelf: thus $27 \div 6$ leaves the remainder 3, its root; 215, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which, added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which, added to 6, is the cube root. Hence the remainders of the divifions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube fo divided, till that remainder be 5, and confequently 11, the cube-root of the number divided. But the cubic numbers above this, being divided by 6, there remains nothing, the cube root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6; till you come to 18, when the remainder of the divifion muft be added to 18; and fo on *ad infinitum*.

Determinate number is that referred to fome given unit, as a ternary or three: whereas an indeterminate one is that referred to unity in general, and is called *quantity*.

Homogeneal numbers, are thofe referred to the fame unit; as thofe referred to different units are termed *heterogeneal*.

Whole numbers are others called *integers*.

Rational number, is one commenfurable with unity; as a number, incommenfurable with unity, is termed *irrational*, or a *furd*.

In the fame manner, a rational whole number is that whereof unity is an aliquot part; a rational broken number, that equal to fome aliquot part of unity; and a rational mixed number, that confifting of a whole number and a broken one.

Even number, that which may be divided into two equal parts without any fraction, as 6, 12, *&c.* The fum, difference, and product, of any number of even numbers, is always an even number.

An evenly even number, is that which may be meafured, or divided, without any remainder, by another even number, as 4 by 2.

An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5.

Uneven number, that which exceeds an even number, at leaft by unity, or which cannot be divided into two

two equal parts, as 3, 5, *&c.*

The ſum or difference of two uneven numbers makes an even number; but the factum of two uneven ones makes an uneven number.

If an even number be added to an uneven one, or if the one be ſubtracted from the other, in the former caſe the ſum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even.

The ſum of any even number of uneven numbers is an even number; and the ſum of any uneven number of uneven numbers is an uneven number.

Primitive or prime numbers, are thoſe diviſible only by unity, as 5, 7, *&c.* And prime numbers among themſelves, are thoſe which have no common meaſure beſides unity, as 12 and 19.

Perfect number, that whoſe aliquot parts added together make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1=6; and thoſe of 28, being 14, 7, 4, 2, 1, =28.

Imperfect numbers, thoſe whoſe aliquot parts added together make either more or leſs than the whole. And theſe are diſtinguiſhed into abundant and defective: an inſtance in the former caſe is 12, whoſe aliquot parts 6, 4, 3, 2, 1, make 16; and in the latter caſe 16, whoſe aliquot parts 8, 4, 2, and 1, make but 15.

Plain number, that ariſing from the multiplication of two numbers, as 6, which is the product of 3 by 2; and theſe numbers are called the *ſides of the plane.*

Square number is the product of any number multiplied by itſelf; thus 4, which is the factum of 2 by 2, is a ſquare number.

Even ſquare number added to its root makes an even number.

Polygonal or polygonous numbers, the ſums of arithmetical progreſſions beginning with unity: theſe, where the common difference is 1, are called *triangular numbers;* where 2, *ſquare numbers;* where 3, *pentagonal numbers;* where 4, *hexagonal numbers;* where 5, *heptagonal numbers,* &c.

Pyramidal numbers, the ſums of polygonous numbers, collected after the ſame manner as the polygons themſelves, and not gathered out of arithmetical progreſſions, are called *firſt pyramidal numbers:* the ſums of the firſt pyramidals are called *ſecond pyramidals,* &c.

If they ariſe out of triangular numbers, they are called *triangular pyramidal numbers;* if out of pentagons, *firſt pentagonal pyramidals.*

From the manner of ſumming up polygonal numbers, it is eaſy to conceive how the prime pyramidal numbers are found, *viz.* $\frac{(a-2)n^3+3n^3-(a-5)n}{6}$ expreſſes all the prime pyramidals.

The following curious property of the number 9 deſerves to be remarked, That its products compoſe always either 9 or ſome leſſer product of 9; if you add together all the characters, of which any of the former products is compoſed. Thus, of 18, 27, 36, which are products of 9, you make 9 by adding 1 to 8, 2 to 7, 3 to 6. Thus 369 is a product alſo of 9; and if you add 3, 6, and 9, you make 18, a leſſer product of 9.

Golden NUMBER, See ASTRONOMY, nº 304—307.

NUMBERS, in poetry, oratory, &c. are certain meaſures, proportions, or cadences, which render a verſe, period, or ſong, agreeable to the ear,

Poetical numbers conſiſt in a certain harmony in the order, quantities, &c. of the feet and ſyllables, which make the piece muſical to the ear, and fit for ſinging, for which all the verſes of the ancients were intended. See POETRY.—It is of theſe numbers Virgil ſpeaks in his ninth Eclogne, when he makes Lycidas ſay, *Numeros memini, ſi verba tenerem;* meaning, that although he had forgot the words of the verſes, yet he remembered the feet and meaſure of which they were compoſed.

Rhetorical or proſaic numbers are a ſort of ſimple unaffected harmony, leſs glaring than that of verſe, but ſuch as is perceived and affects the mind with pleaſure.

The numbers are that by which the ſtyle is ſaid to be eaſy, free, round, flowing, &c. Numbers are things abſolutely neceſſary in all writing, and even in all ſpeech. Hence Ariſtotle, Tully, Quintilian, &c. lay down abundance of rules as to the beſt manner of intermixing dactyles, ſpondees, anapeſts, &c. in order to have the numbers perfect. The ſubſtance of what they have ſaid, is reducible to what follows. 1. The ſtyle becomes numerous by the alternate diſpoſition and temperature of long and ſhort ſyllables, ſo as that the multitude of ſhort ones neither render it too haſty, nor that of long ones too ſlow and languid: ſometimes, indeed, long and ſhort ſyllables are thrown together deſignedly without any ſuch mixture, to paint the ſlowneſs or celerity of any thing by that of the numbers; as in theſe verſes of Virgil:

Illi inter ſeſe magna vi brachia tollunt;

and

Radit iter liquidum, celeres neque commovet alas.

2. The ſtyle becomes numerous, by the intermixing words of one, two, or more ſyllables; whereas the too frequent repetition of monoſyllables renders the ſtyle pitiful and grating. 3. It contributes greatly to the numerouſneſs of a period, to have it cloſed by magnificent and well-ſounding words. 4. The numbers depend not only on the nobleneſs of the words in the cloſe, but of thoſe in the whole tenor of the period. 4. To have the period flow eaſily and equally; the harſh concurrence of letters and words is to be ſtudiouſly avoided, particularly the frequent meeting of rough conſonants; the beginning the firſt ſyllable of a word with the laſt of the preceding; the frequent repetition of the ſame letter or ſyllable; and the frequent uſe of the like ending words. Laſtly, the utmoſt care is to be taken leſt, in aiming at oratorial numbers, you ſhould fall into poetical ones; and inſtead of proſe, write verſe.

Book of NUMBERS, the fourth book of the Pentateuch, taking its denomination from its numbering the families of Iſrael.

A great part of this book is hiſtorical, relating to ſeveral remarkable paſſages in the Iſraelites march through the wilderneſs. It contains a diſtinct relation of their ſeveral movements from one place to another, or their 42 ſtages through the wilderneſs, and many other things, whereby we are inſtructed and confirmed

ed in some of the weightiest truths that have immediate reference to God and his providence in the world. But the greatest part of this book is spent in enumerating those laws and ordinances, whether civil or ceremonial, which were given by God, but not mentioned before in the preceding books.

NUMERAL LETTERS, those letters of the alphabet which are generally used for figures; as I, one; V, five; X, ten; L, fifty; C, a hundred; D, five hundred; M, a thousand, &c.

It is not agreed how the Roman numerals originally received their value. It has been supposed that the Romans used M to denote 1000, because it is the first letter of *mille*, which is Latin for 1000; and C to denote 100, because it is the first letter of *centum*, which is Latin for 100. It has also been supposed, that D being formed by dividing the old M in the middle, was therefore appointed to stand for 500, that is, half as much as the M stood for when it was whole; and that L being half a C, was, for the same reason, used to denominate 50. But what reason is there to suppose, that 1000 and 100 were the numbers which letters were first used to express? And what reason can be assigned why D, the first letter in the Latin word *decem*, ten, should not rather have been chosen to stand for that number, than for 500 because it had a rude resemblance to half an M? But if these questions could be satisfactorily answered, there are other numeral letters which have never yet been accounted for at all. These considerations render it probable, that the Romans did not, in their original intention, use letters to express numbers at all; the most natural account of the matter seems to be this:

The Romans probably put down a single stroke, I, for one, as is still the practice of those who score on a slate or with chalk: this stroke, I, they doubled, trebled, and quadrupled, to express 2, 3, and 4: thus, II. III. IIII. So far they could easily number the minums, or strokes, with a glance of the eye. But they presently found, that if more were added, it would soon be necessary to tell the strokes one by one: for this reason, when they came to 5, they expressed it by joining two strokes together in an acute angle thus, V; which will appear the more probable, if it be considered, that the progression of the Roman numbers is from 5 to 5, *i. e.* from the fingers on one hand to the fingers on the other.—Ovid has touched upon the original of this in his *Fastorum* lib. iii. and *Vitruv*. lib. c. 1. has made the same remark.

After they had made this acute angle V. for five, they added the single strokes to it to the number of 4, thus, VI. VII. VIII. VIIII. and then as the minums could not be further multiplied without confusion, they doubled their acute angle, by prolonging the two lines beyond their intersection thus, X. to denote two fives, or ten. After this they doubled, trebled, and quadrupled, this double acute angle thus, XX. XXX. XXXX. they then, for the same reason which induced them first to make a single and then to double it, joined two single strokes in another form, and instead of an acute angle, made a right angle L, to denote fifty. When this 50 was doubled, they then doubled the right angle thus ⊏, to denote 100, and having numbered this double right angle four times, thus ⊏⊏. ⊏⊏⊏. ⊏⊏⊏⊏; when they came to the fifth number, as before, they reverted it, and put a single stroke before it thus I⊐, to denote 500; and when this 500 was doubled, then they also doubled their double right angle, setting two double right angles opposite to each other, with a single stroke between them, thus ⊏I⊐ to denote 1000: when this note for 1000 had been four times repeated, then they put down I⊐⊐ for 5,000, ⊏⊏I⊐⊐ for 10,000, and I⊐⊐⊐ for 50,000, ⊏⊏⊏I⊐⊐⊐ for 100,000, I⊐⊐⊐⊐ for 500,000, and ⊏⊏⊏⊏I⊐⊐⊐⊐ for one million.

That the Romans did not originally write M for 1000, and C for 100, but square characters, as they are written above, we are expressly informed by Paulus Manutius; but the corners of the angles being cut off by the transcribers for dispatch, these figures were gradually brought into what are now numeral letters. When the corners of ⊏I⊐, were made round, it stood thus CIↃ, which is so near the Gothic m, that it soon deviated into that letter; so I⊐ having the corner made round, it stood thus IↃ, and then easily deviated into D. ⊏ also became a plain C by the same means; the single rectangle which denoted 50, was, without alteration, a capital L; the double acute angle was an X; the single acute angle a V consonant; and a plain single stroke, the letter I,; and thus these seven letters, M, D, C, L, X, V, I, became numerals.

NUMERATION, or NOTATION, in arithmetic, the art of expressing in characters any number proposed in words, or of expressing in words any number proposed in characters. See ARITHMETIC, p. 653.

NUMERICAL, NUMEROUS, or *Numeral*, something belonging to numbers; as numerical algebra is that which makes use of numbers, instead of letters of the alphabet.—Also numerical difference is that by which one man is distinguished from another. Hence a thing is said to be numerically the same, when it is so in the strictest sense of the word.

NUMIDA, in ornithology, a genus belonging to the order of gallinæ. On each side of the head there is a kind of coloured fleshy horn; and the beak is furnished with cere near the nostrils. There is but one species, the meleagris, or Guinea-hen; a native of Africa. It is of the size of the common hen, but with a longer neck. Its body is sloped like that of a partridge, and its colour is all over a dark grey, very beautifully spotted with small white specks; there is a black ring round the neck; its head is reddish, and it is blue under the eyes. They naturally herd together in large numbers, and breed up their young in common; the females taking care of the broods of others, as well as of their own. Barbot informs us, that in Guinea they are in flocks of 200 or 300, that perch in trees, and feed on worms and grasshoppers; that they are run down and taken by dogs; and that their flesh is tender and sweet, generally white, though sometimes black. They breed very well with us.

NUMIDIA, an ancient kingdom of Africa, bounded on the north by the Mediterranean Sea; on the south by Gætulia, or part of Libya Interior; on the west by the Mulucha, a river which separated it from Mauritania; and on the east by the Tusca, another river which bounded it in common with Africa Propria. Dr Shaw has rendered it probable, that the river which formerly went under the denominations of

Malva,

Numidia. *Malva*, *Malvana*, *Mulucha*, and *Molochath*, is the ſame with that now called Mullooiah by the Algerines; in which caſe, the kingdom of Numidia muſt have extended upwards of 500 miles in length: its breadth, however, cannot be ſo well aſcertained; but ſuppoſing it to have been the ſame with that of the preſent kingdom of Algiers, in the narroweſt part it muſt have been at leaſt 40 miles broad, and in the wideſt upwards of 100.

1 Ancient diviſion. This county included two diſtricts; one inhabited by the *Maſſyli*, and the other by the *Maſæſyli*; the latter being alſo called in after-times, *Mauritania Cæſarienſis*, and the former *Numidia Propria*. The country of the Maſſyli, or, as ſome call it, *Terra Metagonitis*, was ſeparated from the proper territory of Carthage by its eaſtern boundary the river Tuſca, and from the kingdom of the Maſæſyli, or Mauritania Cæſarienſis, by the river Ampſaga. It ſeems to correſpond with that part of the province of Conſtantina lying between the Zaine and the Wed al Kibeer, which is above 130 miles long, and more than 100 broad. The ſea-coaſt of this province is for the moſt part mountainous and rocky, anſwering to the appellation given to it by Abulfeda, viz. *El Edwaa*, *the high* or *lofty*. It is far from being equal in extent to the ancient country of the Maſæſyli, which, Strabo informs us, was yet inferior to the country of the Maſſyli. Its capital was Cirta, a place of very conſiderable note among the ancients.

2 Peopled by the deſcendants of Phut. The moſt celebrated antiquarians agree, that the tract, extending from the iſthmus of Suez to the lake Tritonis, was chiefly peopled by the deſcendants of Mizraim; and that the poſterity of his brother Put, or Phut, ſpread themſelves all over the country between that lake and the Atlantic ocean. To this notion Herodotus gives great countenance: for he tells us, that the Libyan Nomades, whoſe territories to the weſt were bounded by the Triton, agreed in their cuſtoms and manners with the Egyptians; but that the Africans from that river to the Atlantic Ocean, differed in almoſt all points from them. Ptolemy mentions a city called *Putea* near Adrametum; and Pliny, a river of Mauritania Tingitana, known by the name of *Fut*, or *Phut*; and the diſtrict adjacent to this river was called *Regio Phutenſis*, which plainly alludes to the name of *Phut*. That word ſignifies *ſcattered*, or *diſperſed*, which very well agrees with what Mela and Strabo relate of the ancient Numidians; ſo that we may, without any ſcruple, admit the Aborigines of this country to have been the deſcendants of Phut.

3 Great part of the hiſtory unknown. The hiſtory of Numidia, during many of the early ages, is buried in oblivion. It is probable, however, that as the Phœnicians were maſters of a great part of the country, theſe tranſactions had been recorded, and generally known to the Carthaginians. King Jarbas probably reigned here as well as in Africa Propria, if not in Mauritania, and other parts of Libya, when Dido began to build Byrſa. It appears from Juſtin, that about the age of Herodotus, the people of this country were called both *Africans* or *Libyans* and *Numidians*. Juſtin likewiſe intimates, that about this time the Carthaginians vanquiſhed both the Moors or Mauritanians, and Numidians; in conſequence of which they were excuſed from paying the tribute which had hitherto been demanded of them. Numidia.

After the concluſion of the firſt Punic war, the African troops carried on a bloody conteſt againſt their maſters the Carthaginians; and the moſt active in this rebellion, according to Diodorus Siculus, were a part of the Numidian nation named *Micatanians*. This ſo incenſed the Carthaginians, that after Hamilcar had either killed or taken priſoners all the mercenaries, he ſent a large detachment to ravage the country of thoſe Numidians. The commandant of that detachment executed his orders with the utmoſt cruelty, plundering the diſtrict in a terrible manner, and crucifying all the priſoners, without diſtinction, that fell into his hands. This filled the reſt with ſuch indignation and reſentment, that both they and their poſterity ever afterwards bore an implacable hatred to the Carthaginians.

In the time of the ſecond Punic war, Syphax, king of the Maſæſyli, entered into an alliance with the Romans, and gave the Carthaginians a conſiderable defeat. This induced Gala, king of the Maſſyli, to conclude a treaty with the Carthaginians, in conſequence of which his ſon Maſiniſſa marched at the head of a powerful army to give Syphax battle. The conteſt ended in favour of Maſiniſſa; 30,000 of the Maſſæſyli were put to the ſword, and Syphax driven into Mauritania; and the like bad ſucceſs attended Syphax in another engagement, where his troops were entirely defeated and diſperſed. 4 Hiſtory of Syphax and Maſiniſſa.

Gala dying whilſt his ſon Maſiniſſa was acting at the head of the Numidian troops ſent to the aſſiſtance of the Carthaginians in Spain, his brother Deſalces, according to the eſtabliſhed rules of ſucceſſion in Numidia, took poſſeſſion of the Maſſylian throne. That prince dying ſoon after his acceſſion, Capuſa his eldeſt ſon ſucceeded him. But he did not long enjoy his high dignity; for one Mezetulus, a perſon of the royal blood, but an enemy to the family of Gala, found means to excite a great part of his ſubjects to revolt. A battle ſoon took place between him and Capuſa; in which the latter was ſlain with many of the nobility, and his army entirely defeated. But tho' Mezetulus thus became poſſeſſed of the ſovereignty, he did not think proper to aſſume the title of *king*, but ſtyled himſelf guardian to Lacumaces, the ſurviving ſon of Deſalces, whom he graced with the royal title. To ſupport himſelf in his uſurpation, he married the dowager of Deſalces, who was Hannibal's niece, and conſequently of the moſt powerful family in Carthage. In order to attain the ſame end, he ſent ambaſſadors to Syphax, to conclude a treaty of alliance with him. In the mean time Maſiniſſa, receiving advice of his uncle's death, of his couſin's ſlaughter, and of Mezetulus's uſurpation, immediately paſſed over to Africa, and went to the court of Bocchar king of Mauritania, to ſolicit ſuccours. Bocchar, ſenſible of the great injuſtice done Maſiniſſa, gave him a body of 4000 Moors to eſcort him to his dominions. His ſubjects, having been appriſed of his approach, joined him upon the frontiers with a party of 500 men. The Moors, in purſuance of their orders, returned home, as ſoon as Maſiniſſa reached the confines of his kingdom. Notwithſtanding which, and the ſmall body that declared for him having accidentally met Lacumaces at Thapſus with an eſcort going to

Numidia. to implore Syphax's affiftance, he drove him into the town, which he carried by affault, after a faint refiftance. However, Lacumaces, with many of his men, found means to efcape to Syphax. The fame of this exploit gained Mafiniffa great credit, infomuch that the Numidians flocked to him from all parts, and, amongft the reft, many of his father Gala's veterans, who preffed him to make a fpeedy and vigorous pufh for his hereditary dominions. Lacumaces having joined Mezetulus with a reinforcement of Maffæfylians, which he had prevailed upon Syphax to fend to the affiftance of his ally, the ufurper advanced at the head of a numerous army to offer Mafiniffa battle; which that prince, though much inferior in numbers, did not decline. Hereupon an engagement enfued; which, notwithftanding the inequality of numbers, ended in the defeat of Lacumaces. The immediate confequence of this victory to Mafiniffa, was a quiet and peaceable poffeffion of his kingdom; Mezetulus and Lacumaces, with a few that attended them, flying into the territories of Carthage. However, being apprehenfive that he fhould be obliged to fuftain a war againft Syphax, he offered to treat Lacumaces with as many marks of diftinction as his father Gala had Defalces; provided that prince would put himfelf under his protection. He alfo promifed Mezetulus pardon, and a reftitution of all the effects forfeited by his treafonable conduct, if he would make his fubmiffion to him. Both of them readily complied with the propofal, and immediately returned home; fo that the tranquillity and repofe of Numidia would have been fettled upon a folid and lafting foundation, had not this been prevented by Afdrubal, who was then at Syphax's court. He infinuated to that prince, who was difpofed to live amicably with his neighbours, "That he was greatly miftaken, if he imagined Mafiniffa would be fatisfied with his hereditary dominions. That he was a prince of much greater capacity and ambition, than either his father Gala, his uncle Defalces, or any of his family. That he had difcovered in Spain marks of a moft rare and uncommon merit. And that, in fine, unlefs his rifing flame was extinguifhed before it came to too great a head, both the Maffæfylian and Carthaginian ftates would be infallibly confumed by it." Syphax, alarmed by thefe fuggeftions, advanced with a numerous body of forces into a diftrict, which had long been in difpute between him and Gala, but was then in poffeffion of Mafiniffa. This brought on a general action between thefe two princes; wherein the latter was totally defeated, his army difperfed, and he himfelf obliged to fly to the top of mount Balbus, attended only by a few of his horfe. Such a decifive battle at the prefent juncture, before Mafiniffa was fixed in his throne, could not but put Syphax into poffeffion of the kingdom of the Maffyli. Mafiniffa in the mean time made nocturnal incurfions from his poft upon mount Balbus, and plundered all the adjacent country, particularly that part of the Carthaginian territory contiguous to Numidia. This diftrict he not only thoroughly pillaged, but likewife laid wafte with fire and fword, carrying off from thence an immenfe booty, which was bought by fome merchants, who had put into one of the Carthaginian ports for that purpofe. In fine, he did the Carthaginians more damage, not only by committing fuch dreadful devaftations, but by maffacring and carrying into captivity vaft numbers of their fubjects on this occafion, than they could have fuftained in a pitched battle, or one campaign of a regular war. Syphax, at the preffing and reiterated inftances of the Carthaginians, fent Bocchar, one of his moft active commanders, with a detachment of 4000 foot, and 2000 horfe, to reduce this peftilent gang of robbers, promifing him a great reward if he could bring Mafiniffa either alive or dead. Bocchar, watching an opportunity, furprifed the Maffylians, as they were ftraggling about the country without any order or difcipline; fo that he took many prifoners, difperfed the reft, and purfued Mafiniffa himfelf, with a few of his men, to the top of the mountain where he had before taken poft. Confidering the expedition as ended, he not only fent many head of cattle, and the other booty that had fallen into his hands, to Syphax, but likewife all the forces, except 500 foot and 200 horfe. With this detachment he drove Mafiniffa from the fummit of the hill, and purfued him through feveral narrow paffes and defiles, as far as the plains of Clupea. Here he fo furrounded him, that all the Maffylians, except four, were put to the fword, and Mafiniffa himfelf, after having received a dangerous wound, efcaped with the utmoft difficulty. As this was effected by croffing a rapid river, in which attempt two of his four attendants perifhed in the fight of the detachment that purfued him, it was rumoured all over Africa, that Mafiniffa alfo was drowned; which gave inexpreffible pleafure to Syphax and the Carthaginians. For fome time he lived undifcovered in a cave, where he was fupported by the robberies of the two horfemen that had made their efcape with him. But having cured his wound by the application of fome medicinal herbs, he boldly began to advance towards his own frontiers, giving out publicly that he intended once more to take poffeffion of his kingdom. In his march he was joined by about 40 horfe, and, foon after his arrival amongft the Maffyli, fo many people flocked to him from all parts, that out of them he formed an army of 6000 foot, and 4000 horfe. With thefe forces, he not only reinftated himfelf in the poffeffion of his dominions, but likewife laid wafte the borders of the Maffæfyli. This fo irritated Syphax, that he immediately affembled a body of troops, and encamped very commodioufly upon a ridge of mountains between Cirta and Hippo. His army he commanded in perfon; and detached his fon Vermina, with a confiderable force, to take a compafs, and attack the enemy in the rear. In purfuance of his orders, Vermina fet out in the beginning of the night, and took poft in the place appointed him, without being difcovered by the enemy. In the mean time Syphax decamped, and advanced towards the Maffyli, in order to give them battle. When he had poffeffed himfelf of a rifing ground that led to their camp, and concluded that his fon Vermina muft have formed the ambufcade behind them, he began the fight. Mafiniffa being advantageoufly pofted, and his foldiers diftinguifhing themfelves in an extraordinary manner, the difpute was long and bloody. But Vermina unexpectedly falling upon their rear, and by this means obliging them to divide their forces, which were fcarce able before to oppofe the main body under Syphax,

Numidia. phax, they were soon thrown into confusion, and forced to betake themselves to a precipitate flight. All the avenues being blocked up, partly by Syphax, and partly by his son, such a dreadful slaughter was made of the unhappy Massyli, that only Masinissa himself, with 60 horse, escaped to the Lesser Syrtis. Here he remained, betwixt the confines of the Carthaginians and Garamantes, till the arrival of Lælius and the Roman fleet on the coast of Africa. What happened immediately after this junction with the Romans, belongs to the article ROME.

It will be sufficient therefore in this place to observe, that, by the assistance of Lælius, Masinissa at last reduced Syphax's kingdom. According to Zonaras, Masinissa and Scipio, before the memorable battle of Zama, by a stratagem deprived Hannibal of some advantageous posts; which, with a solar eclipse happening during the heat of the action, and not a little intimidating the Carthaginian troops, greatly contributed to the victory the Romans obtained. At the conclusion therefore of the second Punic war, he was amply rewarded by the Romans for the important services he had done them. As for Syphax, after the loss of his dominions, he was kept in confinement for some time at Alba; from whence being removed in order to grace Scipio's triumph, he died at Tibur in his way to Rome. Zonaras adds, that his corpse was decently interred; that all the Numidian prisoners were released; and that Vermina, by the assistance of the Romans, took peaceable possession of his father's throne. However, part of the Massæsylian kingdom had been before annexed to Masinissa's dominions, in order to reward that prince for his singular fidelity and close attachment to the Romans.

This seems to be countenanced by the epitomizer of Livy, who gives us sufficiently to understand, that Syphax's family, for a considerable term after the conclusion of the second Punic war, reigned in one part of Numidia. For he intimates, that Archobarzanes, Syphax's grandson, and probably Vermina's son, hovered with a powerful army of Numidians upon the Carthaginian frontiers a few years before the beginning of the third Punic war. This he seems to have done, either in order to cover them, or to enable the Carthaginians to make an irruption into Masinissa's territories. Cato, however, pretended that these forces, in conjunction with those of Carthage, had a design to invade the Roman dominions, which he urged as a reason to induce the conscript fathers to destroy the African republic.

Nothing is further requisite, in order to complete the history of this famous prince, than to exhibit to our readers view some points of his conduct towards the decline, and at the close, of life; the wise dispositions made after his death by Æmilianus, in order to the regulation of his domestic affairs; and some particulars relating to his character, genius, and habit of body, drawn from the most celebrated Greek and Roman authors.

By drawing a line of circumvallation around the Carthaginian army under Asdrubal, posted upon an eminence, Masinissa cut off all manner of supplies from them; which introduced both the plague and famine into their camp. As the body of Numidian troops employed in this blockade was not near so numerous as the Carthaginian forces, it is evident, that the line here mentioned must have been extremely strong, and consequently the effect of great labour and art. The Carthaginians, finding themselves reduced to the last extremity, concluded a peace upon the following terms, which Masinissa dictated to them: 1. That they should deliver up all deserters. 2. That they should recal their exiles, who had taken refuge in his dominions. 3. That they should pay him 5000 talents of silver within the space of 50 years. 4. That their soldiers should pass under the jugum, each of them carrying off only a single garment. As Masinissa himself, though between 80 and 90 years of age, conducted the whole enterprise, he must have been extremely well versed in fortification, and other branches of the military art. His understanding likewise he must have retained to the last. This happened a short time before the beginning of the third Punic war. See CARTHAGE.

5 Masinissa displeased with the Romans.

Soon after, the consuls landed an army in Africa, in order to lay siege to Carthage, without imparting to Masinissa their design. This not a little chagrined him, as it was contrary to the former practice of the Romans; who in the preceding war had communicated their intentions to him, and consulted him on all occasions. When, therefore, the consuls applied to him for a body of his troops to act in concert with their forces, he made answer, "That they should have a reinforcement from him when they stood in need of it." It could not but be provoking to him to consider, that after he had extremely weakened the Carthaginians, and even brought them to the brink of ruin, his pretended imperious friends should come to reap the fruits of his victory, without giving him the least intelligence of it.

6 But leaves every thing to the disposal of Æmilianus.

However, his mind soon returned to its natural bias, which was in favour of the Romans. Finding his end approaching, he sent to Æmilianus, then a tribune in the Roman army, to desire a visit from him. What he proposed by this visit, was to invest him with full powers to dispose of his kingdom and estate as he should think proper, for the benefit of his children. The high idea he had entertained of that young hero's abilities and integrity, together with his gratitude and affection for the family into which he was adopted, induced him to take this step. But, believing that death would not permit him to have a personal conference with Æmilianus upon this subject, he informed his wife and children in his last moments, that he had impowered him to dispose in an absolute manner of all his possessions, and to divide his kingdom amongst his sons. To which he subjoined, "I require, that whatever Æmilianus may decree, shall be executed as punctually as if I myself had appointed it by my will." Having uttered these words, he expired, at above 90 years of age.

This prince, during his youth, had met with strange reverses of fortune. However, says Appian, being supported by the divine protection, he enjoyed an uninterrupted course of prosperity for a long series of years. His kingdom extended from Mauritania to the western confines of Cyrenaica; from whence it appears, that he was one of the most powerful princes of Africa. Many of the inhabitants of this vast tract he civilized in a wonderful manner, teaching them to cul-

tivate their ſoil, and to reap thoſe natural advantages which the fertility of ſome parts of their country offered them. He was of a more robuſt habit of body than any of his cotemporaries, being bleſſed with the greateſt health and vigour; which was doubtleſs owing to his extreme temperance, and the toils he inceſſantly ſuſtained. We are informed by Polybius, that ſometimes he ſtood upon the ſame ſpot of ground from morning till evening, without the leaſt motion, and at others continued as long in a ſitting poſture. He would remain on horſeback for ſeveral days and nights together, without being ſenſible of the leaſt fatigue. Nothing can better evince the ſtrength of his conſtitution, than his youngeſt ſon, named *Stembal*, *Sthemba*, or *Stembanus*, who was but four years old at his deceaſe. Though 90 years of age, he performed all the exerciſes uſed by young men, and always rode without a ſaddle. Pliny tells us, that he reigned above 60 years. He was an able commander, and much facilitated the reduction of Carthage. Plutarch from Polybius obſerves, that the day after a great victory won over the Carthaginians, Maſiniſſa was ſeen ſitting at the door of his tent, eating a piece of brown bread. Suidas relates, that, to the laſt, he could mount his horſe without any aſſiſtance. According to Appian, he left a numerous well-diſciplined army, and an immenſe quantity of wealth, behind him.

Maſiniſſa, before his death, gave his ring to his eldeſt ſon Micipſa; but left the diſtribution of all his other effects and poſſeſſions amongſt his children, entirely to Æmilianus. Of 54 ſons that ſurvived him, only three were legitimate, to wit, Micipſa, Guluſſa, and Maſtanabal. Æmilianus, arriving at Cirta after he had expired, divided his kingdom, or rather the government of it, amongſt theſe three, though to the others he gave conſiderable poſſeſſions. To Micipſa, who was a prince of a pacific diſpoſition, and the eldeſt ſon, he aſſigned Cirta, the metropolis, for the place of his reſidence, in excluſion of the others. Guluſſa, the next to him, being a prince of a military genius, had the command of the army, and the tranſacting of all affairs relating to peace or war, committed to his care. And Manaſtabal, the youngeſt, had the adminiſtration of juſtice, an employment ſuitable to his education, allotted him. They enjoyed in common the immenſe treaſures Maſiniſſa had amaſſed, and were all of them dignified by Æmilianus with the royal title. After he had made theſe wiſe diſpoſitions, that young nobleman departed from Cirta, taking with him a body of Numidian troops, under the conduct of Guluſſa, to reinforce the Roman army, that was then acting againſt the Carthaginians.

Maſtanabal and Guluſſa died ſoon after their father, as appears from the expreſs teſtimony of Salluſt. We find nothing more remarkable of theſe princes, beſides what has been already related, than that the latter continued to aſſiſt the Romans in the third Punic war; and that the former was pretty well verſed in the Greek language. Micipſa therefore became ſole poſſeſſor of the kingdom of Numidia. In his reign, and the conſulate of M. Plautius Hypſæus and M. Fulvius Flaccus, according to Oroſius, a great part of Africa was covered with locuſts, which deſtroyed all the produce of the earth, and even devoured dry wood. But at laſt they were all carried by the wind into the African ſea, out of which being thrown in vaſt heaps upon the ſhore, a plague enſued, which ſwept away an infinite number of animals of all kinds. In Numidia only, periſhed 800,000 men, and in Africa Propria 200,000: amongſt the reſt, 30,000 Roman ſoldiers quartered in and about Utica for the defence of the laſt province. At Utica, in particular, the mortality raged to ſuch a degree, that 1500 dead bodies were carried out of one gate in a day. Micipſa had two ſons, Adherbal and Hiempſal, whom he educated in his palace, together with his nephew Jugurtha. That young prince was the ſon of Maſtanabal; but his mother having been only a concubine, Maſiniſſa had taken no great notice of him. However, Micipſa conſidering him as a prince of the blood, took as much care of him as he did of his own children.

7 History of Jugurtha.

Jugurtha poſſeſſed ſeveral eminent qualities, which gained him univerſal eſteem. He was very handſome, endued with great ſtrength of body, and adorned with the fineſt intellectual endowments. He did not devote himſelf, as young men commonly do, to a life of luxury and pleaſure. He uſed to exerciſe himſelf, with perſons of his age, in running, riding, hurling the javelin, and other manly exerciſes, ſuited to the martial genius of the Numidians; and though he ſurpaſſed all his fellow ſportſmen, there was not one of them but loved him. The chace was his only delight; but it was that of lions, and other ſavage beaſts. Salluſt, to finiſh his character, tells us, that he excelled in all things, and ſpoke very little of himſelf.

So conſpicuous an aſſemblage of fine talents and perfections, at firſt charmed Micipſa, who thought them an ornament to his kingdom. However, he ſoon began to reflect, that he was conſiderably advanced in years, and his children in their infancy; that mankind naturally thirſted after power, and that nothing was capable of making men run greater lengths than a vicious and unlimited ambition. Theſe reflections ſoon excited his jealouſy, and determined him to expoſe Jugurtha to a variety of dangers, ſome of which, he entertained hopes, might prove fatal to him. In order to this, he gave him the command of a body of forces which he ſent to aſſiſt the Romans, who were at that time beſieging Numantia in Spain. But Jugurtha, by his admirable conduct, not only eſcaped all thoſe dangers, but likewiſe won the eſteem of the whole army, and the friendſhip of Scipio, who ſent a high character of him to his uncle Micipſa. However, that general gave him ſome prudent advice in relation to his future conduct; obſerving, no doubt, in him certain ſparks of ambition, which, if lighted into a flame, he apprehended might one day be productive of the moſt fatal conſequences.

8 Is dreaded by king Maſiniſſa.

Before this laſt expedition, Micipſa had endeavoured to find out ſome method of taking him off privately; but his popularity amongſt the Numidians obliged that prince to lay aſide all thoughts of this nature. After his return from Spain the whole nation almoſt adored him. The heroic bravery he had ſhewn there, his undaunted courage, joined to the utmoſt calmneſs of mind, which enabled him to preſerve a juſt medium between a timorous foreſight and an impetuous raſhneſs, a circumſtance rarely to be met with in perſons of his age, and above all the advantageous teſtimonials of his conduct given by Scipio, attracted an univerſal

Numidia. versal esteem. Nay, Micipsa himself, charmed with the high idea the Roman general had entertained of his merit, changed his behaviour towards him; resolving, if possible, to win his affection by kindness. He therefore adopted him, and declared him joint heir with his two sons to the crown. Finding, some few years afterwards, that his end approached, he sent for all three to his bed-side; where, in the presence of the whole court, he desired Jugurtha to recollect with what extreme tenderness he had treated him, and consequently to consider how well he had deserved at his hands. He then intreated him to protect his children on all occasions; who, being before related to him by the ties of blood, were now by their father's bounty become his brethren. In order to fix him the more firmly in their interest, he likewise complimented him upon his bravery, address, and consummate prudence. He further insinuated, that neither arms nor treasures constitute the strength of a kingdom; but friends, who are neither won by arms nor gold, but by real services, and an inviolable fidelity. "Now where, (continued he), can we find better friends than in brothers? And how can that man who becomes an enemy to his relations, repose any confidence in, or depend upon strangers?" Then addressing himself to Adherbal and Hiempsal, "And you, (said he), I enjoin always to pay the highest reverence to Jugurtha. Endeavour to imitate, and if possible surpass, his exalted merit, that the world may not hereafter observe Micipsa's adopted son to have reflected greater glory upon his memory than his own children." Soon after, Micipsa, who, according to Diodorus, was a prince of an amiable character, expired. Though Jugurtha did not believe the king to speak his real sentiments with regard to him, yet he seemed extremely pleased with so gracious a speech, and made him an answer suitable to the occasion. However, that prince at the same time was determined within himself to put in execution the scheme he had formed at the siege of Numantia, which was suggested to him by some factious and abandoned Roman officers, with whom he there contracted an acquaintance. The purport of this scheme was, that he should extort the crown by force from his two cousins, as soon as their father's eyes were closed; which they insinuated might easily be effected by his own valour, and the venality of the Romans. Accordingly, a short time after the old king's death, he found means to assassinate Hiempsal in the city of Thirmida where his treasures were deposited, and drive Adherbal out of his dominions. That unhappy prince found himself obliged to fly to Rome, where he endeavoured to engage the conscript fathers to espouse his quarrel; but, notwithstanding the justice of his cause, they had not virtue enough effectually to support him. Jugurtha's embassadors, by distributing vast sums of money amongst the senators, brought them so far over, that a majority palliated his inhuman proceedings. This encouraged those ministers to declare, that Hiempsal had been killed by the Numidians on account of his excessive cruelty; that Adherbal was the aggressor in the late troubles, and that he was only chagrined because he could not make that havoc amongst his countrymen he would willingly have done. They therefore intreated the senate to form a judgment of Jugurtha's behaviour in Africa from his conduct at Numantia, rather than from the suggestions of his enemies. Upon which, by far the greatest part of the senate discovered themselves prejudiced in his favour. A few however, that were not lost to honour, nor abandoned to corruption, insisted upon bringing him to condign punishment. But as they could not prevail, he had the best part of Numidia allotted him, and Adherbal was forced to rest satisfied with the other.

9 Who nevertheless entrusts him with the care of his children.

10 One of whom he murders, and drives out the other.

11 Venality of the Romans.

Jugurtha finding now by experience, that every thing was venal at Rome, as his friends at Numantia had before informed him, thought he might pursue his towering projects without any obstruction from that quarter. He therefore, immediately after the last division of Micipsa's dominions, threw off the mask, and attacked his cousin by open force. As Adherbal was a prince of a pacific disposition, and almost in all respects the reverse of Jugurtha, he was by no means a match for him. The latter therefore pillaged the former's territories, stormed several of his fortresses, and over-ran a good part of his kingdom without opposition. Adherbal, depending on the friendship of the Romans, which his father in his last moments assured him would be a stronger support to him than all the troops and treasures in the universe, dispatched deputies to Rome to complain of these hostilities. But whilst he lost his time in sending thither fruitless deputations, Jugurtha overthrew him in a pitched battle, and soon after shut him up in Cirta. During the siege of this city, a Roman commission arrived there, in order to persuade both parties to an accommodation; but finding Jugurtha untractable, the commissioners returned home without so much as conferring with Adherbal. A second deputation, composed of senators of the highest distinction, with Æmilius Scaurus, president of the senate, at their head, landed some time after at Utica, and summoned Jugurtha to appear before them. That prince at first seemed to be under dreadful apprehensions, especially as Scaurus reproached him with his enormous crimes, and threatened him with the resentment of the Romans if he did not immediately raise the siege of Cirta. However, the Numidian by his address, and the irresistible power of gold, as was afterwards suspected at Rome, so mollified Scaurus, that he left Adherbal at his mercy. In fine, Jugurtha had at last Cirta surrendered to him; upon condition only, that he should spare the life of Adherbal. But the merciless tyrant, in violation of the laws of nature and humanity, as well as the capitulation, when he had got possession of the town, ordered him to be put to a most cruel death. The merchants likewise, and all the Numidians in the place capable of bearing arms, he caused, without distinction, to be put to the sword.

Every person at Rome inspired with any sentiments of humanity, was struck with horror at the news of this tragical event. However, all the venal senators still concurred with Jugurtha's ministers in palliating his enormous crimes. Notwithstanding which, the people, excited thereto by Caius Memmius their tribune, who bitterly inveighed against the venality of the senate, resolved not to let so flagrant an instance of villany go unpunished. This disposition in them induced the conscript fathers likewise to declare their intention to chastise Jugurtha. In order to this, an army was levied to invade Numidia, and the command of it given to the consul Calpurnius Bestia, a person of good abili-

Numidia.

abilities, but rendered unfit for the expedition he was to go upon by his infatiable avarice. Jugurtha being informed of the great preparations making at Rome to attack his dominions, fent his fon thither to avert the impending ftorm. The young prince was plentifully fupplied with money, which he had orders to diftribute liberally amongft the leading men. But Beftia, propofing to himfelf great advantages from an invafion of Numidia, defeated all his intrigues, and got a decree paffed, ordering him and his attendants to depart Italy in ten days, unlefs they were come to deliver up the king himfelf, and all his territories, to the republic by way of dedition. Which decree being notified to them, they returned without fo much as having entered the gates of Rome; and the conful foon after landed with a powerful army in Africa. For fome time he carried on the war there very brifkly, reduced feveral ftrongholds, and took many Numidians prifoners. But upon the arrival of Scaurus, a peace was granted Jugurtha upon advantageous terms. That prince coming from Vacca, the place of his refidence, to the Roman camp, in order to confer with Beftia and Scaurus, and the preliminaries of the treaty being immediately after fettled between them in private conferences, every body at Rome was convinced that the prince of the fenate and the conful had to their avarice facrificed the republic. The indignation therefore of the people in general, difplayed itfelf in the ftrongeft manner. Memmius alfo fired them with his fpeeches. It was therefore refolved to difpatch the prætor Caffius, a perfon they could confide in, to Numidia, to prevail upon Jugurtha to come to Rome, that they might learn from the king himfelf which of their generals and fenators had been feduced by the peftilent influence of corruption. Upon his arrival there, he found means to bribe one Bæbius Salca, a man of great authority amongft the plebeians, but of infatiable avarice, by whofe affiftance he efcaped with impunity. Nay, by the efficacy of gold, he not only eluded all the endeavours of the people of Rome to bring him to juftice, but likewife enabled Bomilcar, one of his attendants, to get Maffiva, an illegitimate fon of Micipfa, affaffinated in the ftreets of Rome. That young prince was advifed by many Romans of probity, well-wifhers to the family of Mafiniffa, to apply for the kingdom of Numidia; which coming to Jugurtha's ears, he prevented the application by this execrable ftep. However, he was obliged to leave Italy immediately.

Jugurtha had fcarce fet foot in Africa when he received advice, that the fenate had annulled the fhameful peace concluded with him by Beftia and Scaurus. Soon after, the conful Albinus tranfported a Roman army into Numidia, flattering himfelf with the hopes of reducing Jugurtha to reafon before the expiration of his confulate. In this, however, he found himfelf deceived; for that crafty prince, by various artifices fo amufed and impofed upon Albinus, that nothing of moment happened that campaign. This rendered him ftrongly fufpected of having betrayed his county, after the example of his predeceffors. His brother Aulus, who fucceeded him in the command of the army, was ftill more unfuccefsful; for after rifing from before Suthul, where the king's treafures were depofited, he marched his forces into a defile out of which he found it impoffible to extricate himfelf. He therefore was obliged to fubmit to the ignominious ceremony of paffing under the *jugum*, with all his men, and to quit Numidia entirely in ten days time, in order to deliver his troops from immediate deftruction. The avaricious difpofition of the Roman commander had prompted him to befiege Suthul, the poffeffion of which place he imagined would make him mafter of all the wealth of Jugurtha, and confequently paved the way to fuch a fcandalous treaty. However, this was declared void as foon as known at Rome, as being concluded without the authority of the people. The Roman troops retired into Africa Propria, which they had now reduced into the form of a Roman province, and there took up their winter-quarters.

Numidia.

In the mean time Caius Mamilius Limetanus, tribune of the people, excited the plebeians to inquire into the conduct of thofe perfons by whofe affiftance Jugurtha had found means to elude all the decrees of the fenate. This put the body of the people into a great ferment; which occafioned a profecution of the guilty fenators, that was carried on, for fome time, with the utmoft heat and violence. Lucius Metellus 12
the conful, during thefe tranfactions, had Numidia Metellus
affigned him for his province, and confequently was fent againft
appointed general of the army deftined to act againft Jugurtha.
Jugurtha. As he perfectly difregarded wealth, the Numidian found him fuperior to all his temptations; which was a great mortification to him. To this he joined all the other virtues which conftitute the great captain; fo that Jugurtha found him in all refpects inacceffible. That prince therefore was now forced to regulate his conduct according to the motions of Metellus, with the greateft caution, and to exert his utmoft bravery, in order to compenfate for that hitherto fo favourable expedient which now began to fail him. Marius, Metellus's lieutenant, being likewife a perfon of uncommon merit, the Romans reduced Vacca, a large opulent city, and the moft celebrated mart in Numidia. They alfo defeated Jugurtha in a pitched battle; overthrew Bomilcar, one of his generals, upon the banks of the Muthullus; and, in fine, forced the Numidian monarch to take fhelter in a place rendered almoft inacceffible by the rocks and woods with which it was covered. However, Jugurtha fignalifed himfelf in a furprifing manner, exhibiting all that could be expected from the courage, abilities, and attention of a confummate general, to whom defpair adminifters frefh ftrength, and fuggefts new lights. But his troops could not make head againft the Romans; they were again worfted by Marius, though they obliged Metellus to raife the fiege of Zama. Jugurtha therefore, finding his country every where ravaged, his moft opulent cities plundered, his fortreffes reduced, his towns burnt, vaft numbers of his fubjects put to the fword and taken prifoners, began to think ferioufly of coming to an accommodation with the Romans. His favourite 13
Bomilcar, in whom he repofed the higheft confidence, Who is be-
but who had been gained over to the enemy by Me- trayed by
tellus, obferving this difpofition, found it no difficult Bomilcar.
matter to perfuade him to deliver up his elephants, money, arms, horfes, and deferters, in whom the main ftrength of his army confifted, into the hands of the Romans. Some of thefe laft, in order to avoid the punifhment due to their crime, retired to Bocchus king of Mauritania, and lifted in his fervice. But Metellus ordering

Numidia.

ordering him to repair to Tifidium, a city of Numidia, there to receive farther directions, and he refufing a compliance with that order, hoftilities were renewed with greater fury than ever. Fortune now feemed to declare in favour of Jugurtha: he retook Vacca, and maffacred all the Roman garrifon, except Turpilius the commandant. However, foon after, a Roman legion feized again upon it, and treated the inhabitants with the utmoft feverity. About this time, one of Maftanabal's fons, named *Gauda*, whom Micipfa in his will had appointed to fucceed to the crown in cafe his two legitimate fons and Jugurtha died without iffue, wrote to the fenate in favour of Marius, who was then endeavouring to fupplant Metellus. That prince having his underftanding impaired by a declining ftate of health, fell a more eafy prey to the bafe and infamous adulation of Marius. The Roman, foothing his vanity, affured him, that as he was the next heir to the crown, he might depend upon being fixed upon the Numidian throne, as foon as Jugurtha was either killed or taken; and that this muft in a fhort time happen, when once he appeared at the head of the Roman army with an unlimited commiffion. Soon after, Bomilcar and Nabdalfa formed a defign to affaffinate Jugurtha, at the inftigation of Metellus; but this being detected, Bomilcar and moft of his accomplices fuffered death. The plot however had fuch an effect upon Jugurtha, that he enjoyed afterwards no tranquillity or repofe. He fufpected perfons of all denominations, Numidians as well as foreigners, of fome black defigns againft him. Perpetual terrors fat brooding over his mind; infomuch that he never got a wink of fleep but by ftealth, and often changed his bed in a low plebeian manner. Starting from his fleep, he would frequently fnatch his fword, and break out into the moft doleful cries: So ftrongly was he haunted by a fpirit of fear, jealoufy, and diftraction!

14 A confpiracy againft him.

Jugurtha having deftroyed great numbers of his friends on fufpicion of their having been concerned in the late confpiracy, and many more of them deferting to the Romans and Bocchus king of Mauritania, he found himfelf, in a manner, deftitute of counfellors, generals, and all perfons capable of affifting him in carrying on the war. This threw him into a deep melancholy, which rendered him diffatisfied with every thing, and made him fatigue his troops with a variety of contradictory motions. Sometimes he would advance with great celerity againft the enemy, and at others retreat with no fmall fwiftnefs from them. Then he refumed his former courage; but foon after defpaired either of the valour or fidelity of the forces under his command. All his movements therefore proved unfuccefsful, and at laft he was forced by Metellus to a battle. That part of the Numidian army which Jugurtha commanded, behaved with fome refolution; but the other fled at the firft onfet. The Romans therefore entirely defeated them, took all their ftandards, and made a few of them prifoners. Not many of them were flain in the action; fince, as Salluft obferves, the Numidians trufted more to their heels than to their arms for fafety in this engagement.

15 He is defeated by Metellus.

Metellus purfued Jugurtha and his fugitives to Thala. His march to this place being through vaft deferts, was extremely tedious and difficult. But being fupplied with leathern bottles and wooden veffels of all fizes taken from the huts of the Numidians, which were filled with water brought by the natives, who had fubmitted to him, he advanced towards that city. He had no fooner begun his march, than a moft copious fhower of rain, a thing very uncommon in thofe defarts, proved a great and feafonable refrefhment to his troops. This fo animated them, that upon their arrival before Thala, they attacked the town with fuch vigour, that Jugurtha, with his family, and treafures depofited therein, thought proper to abandon it. After a brave defence, it was reduced; the garrifon, confifting of Roman deferters, fetting fire to the king's palace, and confuming themfelves, together with every thing valuable to them, in the flames. Jugurtha, being now reduced to great extremities, retired into Gætulia, where he formed a confiderable corps. From thence he advanced to the confines of Mauritania; and engaged Bocchus king of that country, who had married his daughter, to enter into an alliance with him. In confequence of which, having reinforced his Gætulian troops with a powerful body of Mauritanians, he turned the tables upon Metellus, and obliged him to keep clofe within his entrenchments. Salluft informs us, that Jugurtha bribed Bocchus's minifters to influence that prince in his favour; and that having obtained an audience, he infinuated, that, fhould Numidia be fubdued, Mauritania muft be involved in its ruin, efpecially as the Romans feemed to have vowed the deftruction of all the thrones in the univerfe. In fupport of what he advanced, he produced feveral inftances very appofite to the point in view. However, the fame author feems to intimate, that Bocchus was determined to affift Jugurtha againft his enemies by the flight the Romans had formerly fhewn him. That prince, at the firft breaking out of the war, had fent ambaffadors to Rome, to propofe an offenfive and defenfive alliance to the republic; which, though of the utmoft confequence to it at that juncture, a few of the moft venal and infamous fenators, who were abandoned to corruption, prevented from taking effect. This undoubtedly wrought more powerfully upon Bocchus in favour of Jugurtha, than the relation he ftood in to him: For both the Moors and Numidians adapted the number of their wives to their circumftances, fo that fome had 10, 20, &c. to their fhare; their kings therefore were unlimited in this particular, and of courfe all degrees of affinity refulting to them from marriage had little force. It is obfervable, that the pofterity of thofe ancient nations have the fame cuftom prevailing amongft them at this day.

16 Marius fucceeds Metellus.

Such was the fituation of affairs in Numidia, when Metellus received advice of the promotion of Marius to the confulate. But, notwithftanding this injurious treatment, he generoufly endeavoured to draw off Bocchus from Jugurtha, though this would facilitate the reduction of Numidia for his rival. To this end ambaffadors were difpatched to the Mauritanian court, who intimated to Bocchus, "That it would be highly imprudent to come to a rupture with the Romans without any caufe at all; and that he had now a fine opportunity of concluding a moft advantageous treaty with them, which was much preferable to a war. To which they added, that whatever dependence he might place upon his riches, he ought

not

Numidia.

not to run the hazard of losing his dominions by embroiling himself with other states, when he could easily avoid this; that it was much easier to begin a war than to end it, which it was in the power of the victor alone to do; that, in fine, he would by no means consult the interest of his subjects if he followed the desperate fortunes of Jugurtha." To which Bocchus replied, "That for his part there was nothing he wished for more than peace; but that he could not help pitying the deplorable condition of Jugurtha; that if the Romans, therefore, would grant that unfortunate prince the same terms they had offered him, he would bring about an accommodation." Metellus let the Mauritanian monarch know, that it was not in his power to comply with what he desired. However, he took care to keep up a private negotiation with him till the new consul Marius's arrival. By this conduct he served two wise ends. First, he prevented thereby Bocchus from coming to a general action with his troops; which was the very thing Jugurtha desired, as hoping that this, whatever the event might be, would render a reconciliation betwixt him and the Romans impracticable. Secondly, this inaction enabled him to discover something of the genius and disposition of the Moors; a nation, of whom the Romans, till then, had scarce formed any idea; which, he imagined, might be of no small service, either to himself or his successors, in the future prosecution of the war.

Jugurtha, being informed, that Marius, with a numerous army, was landed at Utica, advised Bocchus to retire, with part of the troops, to some place of difficult access, whilst he himself took post upon another inaccessible spot with the remaining corps. By this measure, he hoped the Romans would be obliged to divide their forces, and consequently be more exposed to his efforts and attacks. He likewise imagined, that seeing no formidable body appear, they would believe the enemy in no condition to make head against them; which might occasion a relaxation of discipline, the usual attendant of a too great security, and consequently produce some good effect. However, he was disappointed in both these views. For Marius, far from suffering a relaxation of discipline to take place, trained up his troops, which consisted chiefly of new levies, in so perfect a manner, that they were soon equal in goodness to any consular army that ever appeared in the field. He also cut off great numbers of the Gætulian marauders, defeated many of Jugurtha's parties, and had like to have taken that

17 He gains a great advantage over Jugurtha.

prince himself near the city of Cirta. These advantages, though not of any great importance, intimidated Bocchus, who now made overtures for an accommodation; but the Romans, not being sufficiently satisfied of his sincerity, gave no great attention to them. In the mean time Marius pushed on his conquests, reducing several places of less note, and at last resolved to besiege Capsa. That this enterprize might be conducted with the greater secrecy, he suffered not the least hint of his design to transpire, even amongst any of his officers. On the contrary, in order to blind them, he detached A. Manlius, one of his lieutenants, with some light-armed cohorts, to the city of Lares, where he had fixed his principal magazine, and deposited the military chest. Before Manlius left the camp, that he might the more effectually amuse him, he intimated, that himself with the army should take the same route in a few days: but instead of that, he bent his march towards the Tanais, and in six days time arrived upon the banks of that river. Here he pitched his tents for a short time, in order to refresh his troops; which having done, he advanced to Capsa, and made himself master of it. As the situation of this city rendered it extremely commodious to Jugurtha, whose plan of operations, ever since the commencement of the war, it had exceedingly favoured, he levelled it with the ground after it had been delivered up to the soldiers to be plundered. The citizens likewise, being more strongly attached to that prince than any of the other Numidians, on account of the extraordinary privileges he indulged them with, and of course bearing a more implacable hatred to the Romans, he put to the sword or sold for slaves. The true motive of the consul's conduct on this occasion seems here to be assigned; though we are told by Sallust, in conformity to the Roman genius, that neither avarice nor resentment prompted him to so barbarous an action, but only a desire to strike a terror into the Numidians.

The Numidians, ever after this exploit, dreaded the very name of Marius; who now, in his own opinion, had eclipsed the glory of all his predecessor's great achievements, particularly the reduction of Thala, a city, in strength and situation, nearly resembling Capsa. Following his blow, he gradually presented himself before most of the places of strength in the enemy's country; many of which either opened their gates, or were abandoned, at his approach, being terrified with what had happened to the unfortunate citizens of Capsa. Others taking by force, he laid in ashes; and in short, filled the greatest part of Numidia with blood, horror, and confusion. Then, after an obstinate defence, he reduced a castle that seemed impregnable, seated not far from Mulucha, where Jugurtha kept part of his treasures. In the mean time, Jugurtha not being able to prevail upon Bocchus, by his repeated solicitations, to advance into Numidia, where he found himself greatly pressed, was obliged to have recourse to his usual method of bribing the Mauritanian ministers, in order to put that prince in motion. He also promised him a third part of his kingdom, provided they could either drive the Romans out of Africa, or get all the Numidian dominions confirmed to him by treaty.

So considerable a cession could not fail of engaging Bocchus to support Jugurtha with his whole power. The two African monarchs therefore, having joined their forces, surprised Marius near Cirta as he was going into winter-quarters. The Roman general was so pushed on this occasion, that the barbarians thought themselves certain of victory, and doubted not but they should be able to extinguish the Roman name in Numidia. But their incaution and too great security enabled Marius to give them a total defeat; which was 18 Jugurtha entirely defeated.
followed four days after by so complete an overthrow, that their numerous army, consisting of 90,000 men, by the accession of a powerful corps of Moors, commanded by Bocchus's son Volux, was entirely ruined. Sylla, Marius's lieutenant, most eminently distinguished himself in the last action, which laid the foundation of

of his future greatneſs. Bocchus, now looking upon Jugurtha's condition as deſperate, and not being willing to run the riſk of loſing his dominions, ſhewed a

19 Bocchus delivers up Jugurtha to the Romans

diſpoſition to clap up a peace with Rome. However, the republic gave him to underſtand, that he muſt not expect to be ranked amongſt its friends, till he had delivered up into the conſul's hands Jugurtha, the inveterate enemy of the Roman name. The Mauritanian monarch, having entertained an high idea of an alliance with that ſtate, reſolved to ſatisfy it in this particular; and was confirmed in his reſolution by one Dabar, a Numidian prince, the ſon of Maſſugrada, and deſcended by his mother's ſide from Maſiniſſa. Being cloſely attached to the Romans, and extremely agreeable to Bocchus on account of his noble diſpoſition, he defeated all the intrigues of Aſpar, Jugurtha's miniſter. Upon Sylla's arrival at the Mauritanian court, the affair there ſeemed to be entirely ſettled. However, Bocchus, who was for ever projecting new deſigns, and, like the reſt of his countrymen, in the higheſt degree perfidious, debated within himſelf, whether he ſhould ſacrifice Sylla or Jugurtha, who were both then in his power. He was a long time fluctuating with uncertainty, and combated by a contrariety of ſentiments. The ſudden changes, which diſplayed themſelves in his countenance, his air, and his whole perſon, evidently ſhewed how ſtrongly his mind was agitated. But at laſt he returned to his firſt deſign, to which the bias of his mind ſeemed naturally to lead him. He therefore delivered up Jugurtha into the hands of Sylla, to be conducted to Marius; who, by that ſucceſsful event, happily terminated this dangerous war. The kingdom of Numidia was now reduced to a new form: Bocchus, for his important ſervices, had the country of the Maſſæſyli, contiguous to Mauritania, aſſigned him; which, from this time, took the name of *New Mauritania*. Numidia Propria, or the country of the Maſſyli, was divided into three parts; one of which was given to Hiempſal, another to Mandreſtal, both deſcendants of Maſiniſſa; and the third the Romans annexed to Africa Propria, or the Roman province adjacent to it. What became of Jugurtha after he had graced Marius's triumph, at which ceremony he was led in chains, together with his two ſons, through the ſtreets of Rome, our readers will find related at large in a former part of this work.

20 Tranſactions after the death of Jugurtha.

Jugurtha's two ſons ſurvived him, but ſpent their lives in captivity at Venuſia. However, one of them, named *Oxyntas*, was, for a ſhort time, releaſed from his confinement by Aponius, who beſieged Acerræ in the war between the Romans and the Italian allies. That general brought this prince to his army, where he treated him as king, in order to draw the Numidian forces off from the Roman ſervice. Accordingly thoſe Numidians no ſooner heard that the ſon of their old king was fighting for the allies, than they began to deſert by campanies; which obliged Julius Cæſar the conſul to part with all his Numidian cavalry, and ſend them back into Africa. Some few years after this event, Pompey defeated Cneius Domitius Ahenobarbus, and Hiarbas, one of the kings of Numidia, killing 17,000 of their men upon the ſpot. Not ſatisfied with this victory, that general purſued the fugitives to their camp, which he ſoon forced, put Domitius to the ſword, and took Hiarbas priſoner. He then reduced that part of Numidia which belonged to Hiarbas, who ſeems to have ſucceeded Mandreſtal abovementioned; and gave it to Hiempſal, a neighbouring Numidian prince, deſcended from Maſiniſſa, who had always oppoſed the Marian faction.

21 Cæſar inſults Juba.

Suetonius informs us, that a diſpute happened between Hiempſal and one Maſintha, a noble Numidian, whom, it is probable, he had in ſome reſpect injured when Julius Cæſar firſt began to make a figure in the world. The ſame author adds, that Cæſar warmly eſpouſed the cauſe of Maſintha, and even groſsly inſulted Juba, Hiempſal's ſon, when he attempted to vindicate his father's conduct on this occaſion. He pulled him by the beard, than which a more unpardonable affront could not be offered to an African. In ſhort, he ſcreened Maſintha from the inſults and violence of his enemies; from whence a reaſon may be aſſigned for Juba's adhering ſo cloſely afterwards to the Pompeian faction.

22 Juba defeats one of Cæſar's lieutenants.

In conſequence of the indignity Cæſar had offered Juba, and the diſpoſition it had occaſioned, that prince did Cæſar great damage in the civil wars betwixt him and Pompey. By a ſtratagem he drew Curio, one of his lieutenants, to a general action, which it was his intereſt at that time to have avoided. He cauſed it to be given out all over Africa Propria and Numidia, that he was retired into ſome remote country at a great diſtance from the Roman territories. This coming to Curio's ears, who was then beſieging Utica, it hindered him from taking the neceſſary precautions againſt a ſurpriſe. Soon after, the Roman general receiving intelligence that a ſmall body of Numidians was approaching his camp, he put himſelf at the head of his forces in order to attack them, and, for fear they ſhould eſcape, began his march in the night, looking upon himſelf as ſure of victory. Some of their advanced poſts he ſurpriſed aſleep, and cut them to pieces; which ſtill farther animated him. In ſhort, about day-break he came up with the Numidians, whom he attacked with great bravery, though his men were then faſting, and vaſtly fatigued by their forced and precipitate march. In the mean time, Juba, who, immediately after the propagation of the rumour abovementioned, had taken care to march privately, with the main body of the Numidian army, to ſupport the detachment ſent before to decoy Curio, advanced to the relief of his men. The Romans had met with a great reſiſtance before he appeared; ſo that he eaſily broke them, killed Curio, with a great part of his troops, upon the ſpot, purſued the reſt to their camp, which he plundered, and took many of them priſoners. Moſt of the fugitives, who endeavoured to make their eſcape on board the ſhips in the port of Utica, were either ſlain by the purſuers, or drowned. The remainder fell into the hands of Varus, who would have ſaved them; but Juba, who arrogated to himſelf the honour of this victory, ordered moſt of them to be put to the ſword.

23 Juba overthrown by Cæſar.

This victory infuſed new life and vigour into the Pompeian faction, who thereupon conferred great honours upon Juba, and gave him the title of *king of all Numidia*. But Cæſar and his adherents declared him an enemy to the ſtate of Rome, adjudging to Bocchus and Bogud, two African princes entirely in their intereſt,

tereſt, the ſovereignty of his dominions. Juba afterwards, uniting his forces with thoſe of Scipio, reduced Cæſar to great extremities, and would in all probability have totally ruined him, had he not been relieved by Publius Sittius. That general, having formed a conſiderable corps, conſiſting of Roman exiles, and Mauritanian troops ſent him by Bocchus, according to Dio, or, as Cæſar will have it, Bogud, made an irruption into Gætulia and Numidia, whilſt Juba was employed in Africa Propria. As he ravaged theſe countries in a dreadful manner, Juba immediately returned with the beſt part of his army, to preſerve them from utter deſtruction. However, Cæſar knowing his horſe to be afraid of the enemy's elephants, did not think proper to attack Scipio in the abſence of the Numidian, till his own elephants, and a freſh reinforcement of troops, hourly expected, arrived from Italy. With this acceſſion of ſtrength, he imagined himſelf able to give a good account, both of the Roman forces with which he was to cope, and the barbarians. In the mean time Scipio diſpatched reiterated expreſſes to Juba to haſten to his aſſiſtance; but could not prevail upon him to move out of Numidia, till he had promiſed him the poſſeſſion of all the Roman dominions in Africa, if they could from thence expel Cæſar. This immediately put him in motion; ſo that, having ſent a large detachment to make head againſt Sittius, he marched with the reſt of his troops to aſſiſt Scipio. However, Cæſar at laſt overthrew Scipio, Juba, and Labienus, near the town of Thapſus, and forced all their camps. As Scipio was the firſt ſurpriſed and defeated, Juba fled into Numidia, without waiting for Cæſar's approach; but the body of the Numidians detached againſt Sittius, having been broken and diſperſed by that general, none of his ſubjects there would receive him. Abandoned therefore to deſpair, he ſought death in a ſingle combat with Petreius, and, having killed him, cauſed himſelf to be diſpatched by one of his ſlaves.

24
Numidia reduced to the form of a province.

After this deciſive action, and the reduction of Africa Propria, Cæſar made himſelf maſter of Numidia, which he reduced to a Roman province, appointing Criſpus Salluſtius to govern it in quality of proconſul, with private inſtructions to pillage and plunder the inhabitants, and, by that means, put it out of their power ever to ſhake off the Roman yoke. However, Bocchus and Bogud ſtill preſerved a ſort of ſovereignty in the country of the Maſſæſyli and Mauritania, ſince the former of thoſe princes, having deſerted Cæſar, ſent an army into Spain to aſſiſt the Pompeians; and the latter, with his forces, determined victory to declare for Cæſar at the ever memorable battle of Munda. Bogud, afterwards ſiding with Anthony againſt Octavius, ſent a body of forces to aſſiſt him in Spain; at which time the Tingitanians revolting from him, Bocchus, with an army compoſed of Romans in the intereſt of Octavius, who paſſed over from Spain into Africa, and his own ſubjects, poſſeſſed himſelf of Mauritania Tingitana. Bogud fled to Antony; and Octavius, after the concluſion of the war, honoured the inhabitants of Tingi with all the privileges of Roman citizens. He likewiſe confirmed Bocchus king of Mauritania Cæſarienſis, or the country of the Maſſæſyli, in the poſſeſſion of Tingitania, which he had conquered, as a reward for his important ſervices. In this he imitated the example of his great predeceſſor Julius Cæſar, who divided ſome of the fruitful plains of Numidia among the ſoldiers of P. Sittius, who had conquered great part of that country, and appointed Sittius himſelf ſovereign of that diſtrict. Sittius, as has been intimated above, having taken Cirta, killed Sabura Juba's general, entirely diſperſed his forces, and either cut off or taken priſoners moſt of the Pompeian fugitives that eſcaped from the battle of Thapſus, highly deſerved to be diſtinguiſhed in ſo eminent a manner. After Bocchus's death, Mauritania and the Maſſæſylian Numidia were, in all reſpects, conſidered as Roman provinces.

NUMISMATOGRAPHIA, a term uſed for the deſcription and knowledge of ancient coins and medals, whether of gold, ſilver, or braſs. See COINS and MEDALS.

NUMITOR, the ſon of Procas king of Alba, and the brother of Amulius. Procas dying made him and Amulius joint heirs to the crown, on condition of their reigning annually by turns: but Amulius, on getting poſſeſſion of the throne, excluded Numitor, whoſe ſon Lauſus he ordered to be put to death, and obliged Rhea Sylvia, Numitor's only daughter, to become a veſtal. This princeſs becoming pregnant, declared that ſhe was with child by the god Mars; and afterwards brought forth Rhemus and Romulus, who at length killed Amulius, and reſtored Numitor to the throne, 754 B. C.

NUMMUS, a piece of money otherwiſe called *ſeſtertius*.

NUN, a woman, in ſeveral Chriſtian countries, who devotes herſelf, in a cloiſter or nunnery, to a religious life. See the article MONK.

There were women, in the ancient Chriſtian church, who made public profeſſion of virginity, before the monaſtic life was known in the world, as appears from the writings of Cyprian and Tertullian. Theſe, for diſtinction's ſake, are ſometimes called *eccleſiaſtical virgins*, and were commonly enrolled in the canon or matricula of the church. They differed from the monaſtic virgin chiefly in this, that they lived privately in their fathers houſes, whereas the others lived in communities: but their profeſſion of virginity was not ſo ſtrict as to make it criminal in them to marry afterwards, if they thought fit. As to the conſecration of virgins, it had ſome things peculiar in it: it was uſually performed publicly in the church by the biſhop. The virgin made a public profeſſion of her reſolution, and then the biſhop put upon her the accuſtomed habit of ſacred virgins. One part of this habit was a veil, called the *ſacrum velamen;* another was a kind of mitre or coronet worn upon the head. At preſent, when a woman is to be made a nun, the habit, veil, and ring of the candidate are carried to the altar; and ſhe herſelf, accompained by her neareſt relations, is conducted to the biſhop, who, after maſs and an anthem, the ſubject of which is, "that ſhe ought to have her lamp lighted, becauſe the bridegroom is coming to meet her, pronounces the benediction: then ſhe riſes up, and the biſhop conſecrates the new habit, ſprinkling it with holy-water. When the candidate has put on her religious habit, ſhe preſents herſelf before the biſhop, and ſings, on her knees, *Ancilla Chriſti ſum*, &c.; then ſhe receives the veil, and afterwards the ring, by

by which ſhe is married to Chriſt; and laſtly, the crown of virginity. When ſhe is crowned, an anathema is denounced againſt all who ſhall attempt to make her break her vows.

NUNCIO, or Nuntio, an ambaſſador from the pope to ſome Catholic prince or ſtate, or a perſon who attends on the pope's behalf at a congreſs, or an aſſembly of ſeveral ambaſſadors.

NUNCUPATIVE, in the ſchools, ſomething that is only nominal, or has no exiſtence but in name.

Nuncupative *Will* or *Teſtament*, a will made verbally, and not put in writing. See the articles Will and Testament.

NUNDINA, a godeſs among the ancient Heathens, ſuppoſed to have the care of the purification of infants. And becauſe male-infants were purified nine days after their birth, her name is derived from nonus, or the ninth, though female-infants were purified the eighth day; which purification was called *luſtration* by the Romans.

NUNDINAL, (nundinalis,) a name which the Romans gave to the eight firſt letters of the alphabet, uſed in their kalendar.

This ſeries of letters, A, B, C, D, E, F, G, H, is placed and repeated ſucceſſively from the firſt to the laſt day of the year: one of theſe always expreſſed the market-days, or the aſſemblies called *nundinæ, quaſi novendinæ*, becauſe they returned every nine days. The country people, after working eight days ſucceſſively, came to town the ninth, to ſell their ſeveral commodities, and to inform themſelves of what related to religion and goverment. Thus the nundinal day being under A on the firſt, ninth, ſeventeenth, and twenty-fifth days of January, &c. the letter D will be the nundinal letter of the year following. Theſe nundinals bear a very great reſemblance to the dominical letters, which return every eight days, as the nundinals did every nine.

NUPTIAL rites, the ceremonies attending the ſolemnization of marriage, which are different in different ages and countries.

NUREMBERG, an imperial city of Germany, capital of a teritory of the ſame name, ſituated in E. Long. 11°, N. Lat. 49. 30. It ſtands on the Regnitz, over which it has ſeveral bridges, both of wood and ſtone, at the bottom of a hill, 60 miles from Augſburg, 87 from Munich, 46 from Wurtzburg, and 50 from Ratiſbon; and is thought by ſome to be the Segodunum, and by others the Caſtrum Noricum, of the ancients. It is large and well built, but not very populous. Its fortifications are a double wall, flanked with towers mounting cannon, and a deep ditch. The magiſtrates, and moſt of the inhabitants, are Lutherans. There are a great many churches and chapels in it. In that of St Sebald is a braſs monument of the ſaint; and a picture, repreſenting the creation of the world, by the celebrated Albert Durer, who was a native of the town; but the fineſt church in the town is that of St Giles. In that of the Holy Ghoſt are kept moſt of the jewels of the empire, together with the pretended ſpear with which our Saviour's ſide was pierced, a thorn of his crown, and a piece of the manger wherein he was laid. Here are alſo a great many hoſpitals, one in particular for foundlings, and another for pilgrims; with a gymnaſium, an anatomical theatre, a granary, a fine public library, the old imperial fortreſs or caſtle, ſome remains of the old citadel of the burgraves of Nuremberg, ſeveral Latin ſchools, an academy of painting, a well furniſhed arſenal, a teutonic houſe in which the Roman-catholic ſervice is tolerated, and a mint. Mr Keyſler ſays, there are upwards of 500 ſtreets in it, about 140 fountains, 16 churches, 44 religious houſes, 12 bridges, 10 market-places, and 25000 inhabitants; and that its territories, beſides the capital and four other towns, contains above 500 villages, and about 160 mills on the Regnitz. The trade of this city, though upon the decline, is ſtill very great, many of its manufactures being ſtill exported to all parts of the world; among which may be reckoned a great variety of curious toys in ivory, wood, and metal. The city has alſo diſtinguiſhed itſelf in the arts of painting and engraving. When the emperor Henry VI. aſſiſted at a tournament in Nuremberg, he raiſed 38 burghers to the degree of nobility, the deſcendants of whom are called *patricians*, and have the government of the city entirely in their hands; the whole council, except eight maſters of companies, who are ſummoned only on extraordinary occcaſions, conſiſting of them. Among the fine braſs cannon in the arſenal, is one that is charged at the breech, and may be fired eight times in a minute; and two that carry balls of eighty pounds. The city keeps, in conſtant pay, ſeven companies, conſiſting each, in time of peace, of 100 men, but, in time of war, of 185; two troops of cuiraſſiers, each conſiſting of 85 men; and two companies of invalids. There are alſo 24 companies of burghers, well armed and diſciplined. On the new bridge, which is ſaid to have coſt 100,000 guilders, are two pyramids, on the top of one of which is a dove with an olive branch in her bill, and on the other an imperial black eagle. Muſic alſo flouriſhes greatly in Nuremberg; and thoſe who delight in mechanic arts and manufactures, cannot any where better gratify their curioſity. As an imperial city, it has a ſeat and voice at the diets of the empire and circle, paying to a Roman month one ſeventh part of the common impoſts of the circle, and to the chamber of Wetzlar 812 rix-dollars, each term. The territory belonging to the city is pretty large, containing, beſides two conſiderable foreſts of pine, called the *Sibald* and *Laurence foreſts*, ſeveral towns and villages.

NURSERY, in gardening, is a piece of land ſet apart for raiſing and propagating all ſorts of trees and plants to ſupply the garden and other plantations.

NURSING of children. See Lactatio.

The following obſervations are ſaid to be the reſult of long experience. A child, when it comes into the world, is almoſt a round ball; it is the nurſe's part to aſſiſt nature, in bringing it to a proper ſhape. The child ſhould be laid (the firſt month) upon a thin matraſs, rather longer than the child, which the nurſe will keep upon her lap, that the child may always lie ſtraight, and only ſit up as the nurſe ſlants the matraſs. To ſet a child quite upright before the end of the firſt month, hurts the eyes, by making the white part of the eye appear below the upper eye-lid. Afterwards the nurſe will begin to ſet it up and dance it

An. Reg. vol. vi. p. 130.

it by degrees. The child muft be kept as dry as poffible.

The cloathing fhould be very light, and not much longer than the child, that the legs may be got at with eafe, in order to have them often rubbed in the day with a warm hand or flannel, and in particular the infide of them.

Rubbing a child all over takes off fcurf, and makes the blood circulate. The breaft fhould be rubbed with the hands, one one way, and the other the other way, night and morning at leaft.

The ankle-bones and infide of the knees fhould be rubbed twice a-day; this will ftrengthen thofe parts, and make the child ftretch its knees and keep them flat, which is the foundation of an erect and graceful perfon.

A nurfe ought to keep a child as little in her arms as poffible, left the legs fhould be cramped, and the toes turned inwards. Let her always keep the child's legs loofe. The oftener the pofture is changed, the better.

Toffing a child about, and exercifing it in the open air in fine weather, is of the greateft fervice. In cities, children are not to be kept in hot rooms, but to have as much air as poffible.

Want of exercife is the caufe of large heads, weak and knotted joints, a contracted breaft, which occafions coughs and ftuffed lungs, an ill-fhaped perfon, and waddling gait, befides a numerous train of other i lls.

The child's flefh is to be kept perfectly clean, by conftantly wafhing its limbs, and likewife its neck and ears; beginning with warm water, till by degrees it will not only bear, but like, to be wafhed with cold.

Rifing early in the morning is good for all children, provided they awake of themfelves, which they generally do; but they are never to be waked out of their fleep, and as foon as poffible to be brought to regular fleeps in the day.

When laid in bed or cradle, their legs are always to be laid ftraight.

Children, till they are two or three years old, they muft never be fuffered to walk long enough at a time to be weary.

Girls might be trained to the proper management of children, if a premium were given in free-fchools, workhoufes, &c. to thofe that brought up the fineft child to one year old.

If the mother cannot fuckle the child, get a wholefome cheerful woman, with a young milk, who has been ufed to tend young children. After the firft fix months, fmall broths, and innocent foods of any kind, may do as well as living wholly upon milk.

A principal thing to be always attended to is, to give young children conftant exercife, and to keep them in a proper pofture.

With regard to the child's drefs in the day, let it be a fhirt; a petticoat of fine flannel, two or three inches longer than the child's feet, with a dimitytop (commonly called a *bodice-coat*), to tie behind; over that a furcingle made of fine buckram, two inches broad, covered over with fattin or fine ticken, with a ribbon faftened to it to tie it on, which anfwers every purpofe of ftays, and has none of their inconveniences.

Over this put a robe, or a flip and frock, or whatever you like beft; provided it is faftened behind, and not much longer than the child's feet, that their motions may be ftrictly obferved.

Two caps are to be put on the head, till the child has got moft of its teeth.

The child's drefs for the night may be a fhirt, a blanket to tie on, and a thin gown to tie over the blanket.

NUSANCE, in law, a thing done to the annoyance of another.

Nufances are either public or private.—A public nufance is an offence againft the public in general, either by doing what tends to the annoyance of all the king's fubjects, or by neglecting to do what the common good requires: in which cafe, all annoyances and injuries to ftreets, highways, bridges, and large rivers, as alfo diforderly ale-houfes, bawdy-houfes, gaming-houfes, ftages for rope-dancers, &c. are held to be common nufances.—A private nufance is, when only one perfon or family is annoyed by the doing of any thing; as where a perfon ftops up the light of another's houfe, or builds in fuch a manner that the rain falls from his houfe upon his neighbour's.

NUT, among botanifts, denotes a PERICARPIUM of an extraordinary hardnefs, inclofing a kernel or feed.

NUTATION, in aftronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution, it is twice inclined to the ecliptic, and as often returns to its former pofition.

NUT-HATCH, in ornithology. See SITTA.

NUTMEG, the kernel of a large fruit, not unlike the peach.

The nutmeg, as we receive it, is of a roundifh or oval figure, of a tolerably compact and firm texture, but eafily cut with a knife, and falling to pieces on a fmart blow. Its furface is not fmooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyifh-brown colour on the outfide, and of a beautiful variegated hue within, being marbled with brown and yellow variegations, running in perfect irregularity through its whole fubftance. It is very unctuous and fatty to the touch, when powdered; and is of an extremely agreeable fmell, and of an aromatic tafte.

There are two kinds of nutmeg in the fhops; the one called by authors the *male*, and the other the *female*. The female is the kind in common ufe, and is of the fhape of an olive: the male is long and cylindric, and has lefs of the fine aromatic flavour than the other; fo that it is much lefs efteemed, and people who trade largely in nutmegs will feldom buy it. The *longer male nutmeg*, as we term it, is called by the Dutch the *wild nutmeg*. It is always diftinguifhable from the others, as well by its want of fragrancy, as by its fhape: it is very fubject to be worm-eaten; and is ftrictly forbid, by the Dutch, to be packed up among the other, becaufe it will give occafion to their being worm-eaten too, by the infects getting from it into them, and breeding in all parts of the parcel.

The largeft, heavieft, and moft unctuous of the nutmegs are to be chofen, fuch as are of the fhape of

an olive, and of the moſt fragrant ſmell. The Dutch import them from the Eaſt-Indies.

The tree which produces the nutmeg grows only in the Banda iſlands. It has a pithy wood, an aſh-coloured bark, and flexible branches. The leaves are produced in pairs upon one ſingle ſtem; and, when bruiſed, emit an agreeable odour. The fruit ſucceeds the flowers, which reſemble thoſe of the cherry-tree. It is of the ſize of an egg, and of the colour of an apricot. The outer rind is very thick, and reſembles that of our nuts as they hang upon the tree, opening in the ſame manner when ripe, and diſcovering the nutmeg covered with its mace. It is then time to gather it, to prevent the mace or flower of the nutmeg from growing dry, and the nutmeg from loſing that oil which preſerves it, and in which its excellence conſiſts. Thoſe that are gathered before they are perfectly ripe, are preſerved in vinegar or ſugar, and admired only in Aſia.

This fruit requires nine months to bring it to perfection. After it is gathered, the outer rind is ſtripped off, and the mace ſeparated from it, and laid in the ſun to dry. The nuts require more preparation.— They are ſpread upon hurdles, and dried for ſix weeks by a ſlow fire, in ſheds erected for that purpoſe. They are then ſeparated from the ſhell, and thrown into lime-water, as a neceſſary preſervative againſt worms.

Nutmeg is greatly uſed in our foods, and is of excellent virtue as a medicine; it is a good ſtomachic, promotes digeſtion, and ſtrengthens the ſtomach. It alſo ſtops vomiting; is an excellent remedy in flatuſes; and is happily joined with rhubarb, and other medicines, in diarrhœas. It is obſerved to have a ſoporific virtue, and to exert it too ſtrongly if taken in immoderate quantities. It has a conſiderable degree of aſtringency; and given, after toaſting before the fire till thoroughly dry and crumbly, it has been ſometimes known alone to cure diarrhœas.

NUTRITION, in the animal-œconomy, is the repairing the continual loſs which the different parts of the body undergo. The motion of the parts of the body, the friction of theſe parts with each other, and eſpecially the action of the air, would deſtroy the body entirely, if the loſs was not repaired by a proper diet, containing nutritive juices; which being digeſted in the ſtomach, and afterwards converted into chyle, mix with the blood, and are diſtributed through the whole body for its nutrition.

In young perſons, the nutritive juices not only ſerve to repair the parts that are damaged, but alſo to increaſe them, which is called *growth*.

In grown perſons, the cuticle is every-where conſtantly deſquamating, and again renewing: and in the ſame manner the parts rubbed off, or otherwiſe ſeparated from the fleſhy parts of the body, are ſoon ſupplied with new fleſh; a wound heals, and an emaciated perſon grows plump and fat.

Buffon, in order to account for nutrition, ſuppoſes the body of an animal or vegetable to be a kind of mould, in which the matter neceſſary to its nutrition is modelled and aſſimilated to the whole. But (continues he) of what nature is this matter which an animal or vegetable aſſimilates to its own ſubſtance? What power is it that communicates to this matter the activity and motion neceſſary to penetrate this mould? and, if ſuch a force exiſt, would it not be by a ſimilar force that the internal mould itſelf might be reproduced?

As to the firſt queſtion, he ſuppoſes that there exiſts in nature an infinite number of living organical parts, and that all organized bodies conſiſt of ſuch organical parts; that their production coſts nature nothing, ſince their exiſtence is conſtant and invariable; ſo that the matter which the animal or vegetable aſſimilates to its ſubſtance, is an organical matter, of the ſame nature with that of the animal or vegetable, which conſequently may augment its volume without changing its form or altering the quality of the ſubſtance in the mould.

As to the ſecond queſtion: There exiſt (ſays he) in nature certain powers, as that of gravity, that have no affinity with the external qualities of the body, but act upon the moſt intimate parts, and penetrate them throughout, and which can never fall under the obſervation of our ſenſes.

And, as to the third queſtion, he anſwers, that the internal mould itſelf is reproduced, not only by a ſimilar power, but it is plain that it is the very ſame power that cauſes the unfolding and reproduction thereof: for it is ſufficient (proceeds he), that in an organized body that unfolds itſelf, there be ſome part ſimilar to the whole, in order that this part may one day become itſelf an organized body, altogether like that of which it is actually a part.

NUX PISTACHIA. See PISTACHIA.

NUX *Vomica*, a flat, compreſſed, round fruit, about the breadth of a ſhilling, brought from the Eaſt Indies. It is found to be a certain poiſon for dogs, cats, &c. and it is not to be doubted that it would alſo prove fatal to mankind. Its ſurface is not much corrugated; and its texture is firm like horn, and of a pale greyiſh-brown colour.

NYCHTHEMERON, the natural day, or day and night, which together make 24 hours.

NYCTALOPIA. See MEDICINE, n° 456.

NYCTANTHES, ARABIAN JASMINE; a genus of the monogynia order, belonging to the diandria claſs of plants. There are five ſpecies; the moſt remarkable of which are, 1. The arbor triſtis, or ſorrowful tree. This tree, or ſhrub, the *pariatacu* of the Bramins, grows naturally in ſandy places in India, particularly in the iſlands of Ceylon and Java, where it is produced in great abundance, and attains the height of 18 or 20 feet. It riſes with a four-cornered ſtem, bearing leaves that are oval, and taper to a point. They ſtand oppoſite, on ſhort foot-ſtalks; are of a ſhining browniſh-green on the upper-ſide, a more vivid green on the under, and of a taſte that is aſtringent and ſomewhat bitter. From the middle-rib, on the under-ſurface of the leaves, proceed on both ſides a number of coſtulæ, or ſmaller ribs, which run nearly to the margin, and mark the ſurface with the impreſſion of their arched furrows. The flowers, which are white, and highly odoriferous, having a ſweet delectable ſmell emulating the beſt honey, conſiſt of one petal deeply divided into eight parts, which are narrower towards the ſtalk, and dilated towards the ſummit. They ſtand upon foot-ſtalks, which emerge from the origin of the leaves; are rigid, obliquely

raifed towards the top, grow oppofite in pairs, and are divided into three fhort leffer branches, which each fupports five flowers placed clofe together, without partial foot-ftalks. The fruit is dry, capfular, membranaceous, and compreffed.

It is generally afferted of this plant, that the flowers open in the evening, and fall off the fucceeding day. Fabricius and Paludanus, however, reftrict the affertion, by affirming, from actual obfervation, that this effect is found to take place only in fuch flowers as are immediately under the influence of the folar rays. Grimmius remarks in his *Laboratorium Ceylonicum*, that the flowers of this tree afford a fragrant water, which is cordial, refrefhing, and frequently employed with fuccefs in inflammations of the eyes. The tube of the flower, when dried, has the fmell of faffron; and, being pounded and mixed with fanders-wood, is ufed by the natives of the Malabar coaft for imparting a grateful fragrancy to their bodies, which they rub or anoint with the mixture.

2. The fambac, noted, like the other fpecies, for the fragrancy of its flowers, is a native likewife of India; and is cultivated in our ftoves, where it generally rifes with a twining ftem, to the height of 18 or 20 feet. The leaves are oppofite, fimple, and entire; but in different parts of the plant affume different forms: the lower leaves being heart-fhaped and blunt; the upper, oval and fharp. The flowers are white, inexpreffibly fragrant, and generally appear with us in the warm fummer-months. Strong loam is its proper foil. There is a variety of this fpecies with a double flower, which is much larger and more fragrant than the former.

NYCTICORAX, in ornithology, the night-raven; a fpecies of Ardea.

NYLAND, a province of Finland in Sweden, lying on the gulf of Finland, to the weft of the province of Carelia.

NYMPH, in mythology, an appellation given to certain inferior goddeffes, inhabiting the mountains, wood, waters, &c. faid to be the daughters of Oceanus and Tethys. All the univerfe was reprefented as full of thefe nymphs, who are diftinguifhed into feveral ranks or claffes. The general divifion of them is into celeftial and terreftrial; the former of which were called *uraniæ*, and were fuppofed to be intelligences that governed the heavenly bodies or fpheres. The terreftrial nymphs, called *epigeiæ*, prefided over the feveral parts of the inferior world; and were divided into thofe of the water, and thofe of the earth. The nymphs of the water were the *oceanitides*, or nymphs of the ocean; the *nereids*, the nymphs of the fea; the *naiads* and *ephydriades*, the nymphs of the fountains; and the *limniades*, or nymphs of the lakes. The nymphs of the earth were the *oreades*, or nymphs of the mountains; the *napææ*, nymphs of the meadows; and the *dryads* and *hamadryads*, who were nymphs of the forefts and groves. Befides thefe, we meet with nymphs who took their names from particular countries, rivers, &c. as the *cithæroniades*, fo called from mount Cithæron in Bœotia; the *dodonides*, from Dodona; *tiberiades*, from the Tiber, &c.—Goats were fometimes facrificed to the nymphs; but their conftant offerings were milk, oil, honey, and wine.

Nymph, among naturalifts, that ftate of winged-infects between their living in the form of a worm, and their appearing in the winged or moft perfect ftate.

The eggs of infects are firft hatched into a kind of worms, or maggots; which afterwards pafs into the nymph-ftate, furrounded with fhells or cafes of their own fkins: fo that, in reality, thefe nymphs are only the embryo infects, wrapped up in this covering; from whence they at laft get loofe, though not without great difficulty.

During this nymph-ftate the creature lofes its motion. Swammerdam calls it *nympha aurelia*, or fimply *aurelia;* and others give it the name of *chryfalis*, a term of the like import. See the article Chrysalis.

Nymphæ, in anatomy, two membranaceous parts, fituated on each fide the rima. They are of a red colour, and cavernous ftructure, fomewhat refembling the wattles under a cock's throat. They are fometimes fmaller, fometimes larger; and are continuous to the præputium of the clitoris, and joined to the interior fide of the labia.

NYMPHÆA, the water-lily; a genus of the monogynia order, belonging to the polyandria clafs of plants. There are four fpecies; of which the moft remarkable are, 1, 2. The lutea and alba, or yellow and white water-lilies; both of which are natives of Britain, growing in lakes and ditches. Linnæus tells us, that fwine are fond of the leaves and roots of the former; and that the fmoke of it will drive away crickets and blattæ, or cock-roaches, out of houfes.—The root of the fecond has an aftringent and bitter tafte, like thofe of moft aquatic plants that run deep into the mud. The Highlanders make a dye with it of a dark cheftnut colour. 3. In the Eaft and Weft Indies grows a fpecies of this plant, named *nelumbo* by the inhabitants of Ceylon. The leaves which reft upon the furface of the water, are fmooth, undivided, perfectly round, thick, target-fhaped, and about one foot and a half in diameter. The footftalk of the leaves is prickly; and inferted, not into their bafe, or margin, as in moft plants, but in the centre of the lower difk or furface. From this centre, upon the upper furface, iffue, like rays, a great number of large ribs, or nerves, which towards the circumference are divided and fubdivided into a fmall number of very minute parts. The flowers are large, flefh-coloured, and confift of numerous petals, difpofed, as in the other fpecies of water-lily, in two or more rows. The feed-veffel is fhaped like a top, being broad and circular above, narrow and almoft pointed below. It is divided into feveral diftinct cells, which form fo many large round holes upon the furface of the fruit; each containing a fingle feed.—With the flower of this plant, which is facred among the heathens, they adorn the altars of their temples: they paint their gods fitting upon it; and make ufe of fuch pictures to animate the minds of the pious on their death-bed, and to raife their affections to heaven. The ftalks, which are ufed as a pot-herb, are of a wonderful length. The root is very long, extends itfelf tranfverfely, is of the thicknefs of a man's arm, jointed and fibrous, with long intervals betwixt the joints. The fibres furround the joints in verticilli, or whirls.

NYMPHEUM, in antiquity, a public hall magnificently decorated, for entertainment, &c. and where thofe who wanted convenience at home held their marriage-

riage-feafts, whence the name.

NYON, a confiderable town of Switzerland, in the canton of Bern, and capital of a bailiwick of the fame name, with a caftle. There are a great many Roman infcriptions here; and it is a trading place, feated in a good country, near the lake of Geneva. E. Long. 5. 10. N. Lat. 46. 24.

NYSLOT, a ftrong town of Ruffia, in Livonia, with a caftle; feated on the river Narva, among large marfhes. E. Long. 26. 55. N. Lat. 58. 46.

NYSSA, a genus of the order of dioecia, belonging to the polygamia clafs of plants. There is but one fpecies, *viz.* The aquatica, or water-tupelo-tree. This has a large trunk, efpecially near the ground, and grows very tall. The leaves are broad, and irregularly notched. The flowers come out from the fides of the branches, on footftalks of three inches long, and are of a greenifh colour. The grain of the wood is foft and fpongy; but the roots much more fo, approaching near to the confiftence of cork; and are ufed for the purpofes of cork in Carolina, where thefe trees are natives. They grow in wet places, and ufually in the fhallow parts of rivers.

O

O, The 14th letter and fourth vowel of our alphabet; pronounced as in the words *nofe*, *rofe*, &c.

The found of this letter is often fo foft as to require it double, and that chiefly in the middle of words; as *goofe*, *reproof*, &c. And in fome words this *oo* is pronounced like *u* fhort, as in *flood*, *blood*, &c.

As a numeral, O is fometimes is ufed for 11; and with a dafh over it thus, $\bar{\text{O}}$, for 11,000.

In the notes of the ancients, O. CON. is read *opus conductum;* O. C. Q. *opera confilioque;* O. D. M. *operæ, donum, munus;* and O. LO. *opus locatum.*

In mufic, the O, or rather a circle, or double CO, is a note of time, called by us a *femi-breve;* and by the Italians, *circolo.* The O is alfo ufed as a mark of triple time, as being the moft perfect of all figures. See TRIPLE.

OAK, in botany. See QUERCUS.

OAK-*Leaves.* The ufes of oak-bark in tanning, and in hot-beds, is generally known. For the latter of thefe purpofes, however, oak-leaves are now found to anfwer equally well, or rather better. In the notes to Dr Hunter's edition to Evelyn's Treatife on Foreft-trees, we find the following directions for their ufe by W. Speechly. The leaves are to be raked up as foon as poffible after they fall from the trees. When raked into heaps, they fhould immediately be carried into fome place near the hot-houfes, where they may lie to couch. Mr Speechly fays it was his cuftom to fence them round with charcoal hurdles, or any thing elfe, to keep them from being blown about the garden in windy weather. In this place they tread them well, and water them in cafe they happen to have been brought in dry. The heap is made fix or feven feet thick, and covered over with old mats, or any thing elfe, to prevent the upper leaves from being blown away. In a few days the heap will come to a ftrong heat. For the firft year or two in which he ufed thefe leaves, our author did not continue them in the heap longer than ten days or a fortnight: but by this method of management they fettled fo much when brought to the hot-houfe, that a fupply was very foon required; and he afterwards found, that it was proper to let them remain five or fix weeks in the heaps before they are brought to the hot-houfe. In getting them into the pine-pits, if they appear dry, they are to be watered, and again trodden down exceedingly well, in layers, till the pits are quite full. The whole is then covered with tan-bark, to the thicknefs of two inches, and well trodden down, till the furface becomes fmooth and even. On this the pine-pots are to be placed in the manner they are to ftand, beginning with the middle row firft, and filling up the fpaces between the pots with tan. In this manner we are to proceed to the next row, till the whole be finifhed; and this operation is performed in the fame manner as when tan only is ufed. The leaves require no further trouble through the whole feafon; as they will retain a conftant and regular heat for 12 months without ftirring or turning; and our author informs us, that if he may judge from their appearance when taken out, (being always entire and perfect), it is probable they would continue their heat through a fecond year; but, as an annual fupply of leaves is eafily obtained, the experiment is hardly worth making. After this, the pines will have no occafion to be moved, but at ftated times of their management, *viz.* at the fhifting them in their pots, &c. when at each time a little frefh tan fhould be added to make up the deficiency arifing from the fettling of the beds; but this will be inconfiderable, as the leaves do not fettle much after their long couching. During the firft two years of our author's practice he did not ufe any tan, but plunged the pine-pots into the leaves, and juft covered the furface of the beds, when finifhed, with a little faw-duft, to give it a neatnefs. This method, however, was attended with one inconvenience; for by the caking of the leaves they fhrunk from the fides of the pots, whereby they became expofed to the air, and at the fame time the heat of the beds was permitted to efcape.

"Many powerful reafons, fays Mr Speechly, may be given why oak-leaves are preferable to tanner's-bark.

"1. They always heat regularly; for during the whole time that I have ufed them, which is near feven years, I never once knew of their heating with violence; and this is fo frequently the cafe with tan, that I affirm, and indeed it is well known to every perfon converfant in the management of the hot-houfe, that pines fuffer more from this one circumftance, than all the other accidents put together, infects excepted.

When this accident happens near the time of their fruiting, the effect is soon seen in the fruit, which is exceedingly small and ill-shaped. Sometimes there will be little or no fruit at all; therefore gardeners who make use of tan only for their pines, should be most particularly careful to avoid an over-heat at that critical juncture,—the time of shewing the fruit.

"2. The heat of oak-leaves is constant; whereas tanner's bark generally turns cold in a very short time after its furious heat is gone off. This obliges the gardener to give it frequent turnings in order to promote its heating. These frequent turnings, not to mention the expence, are attended with the worst consequences; for by the continual moving of the pots backwards and forwards, the pines are exposed to the extremes of heat and cold, whereby their growth is considerably retarded; whereas, when leaves are used, the pines will have no occasion to be moved but at the times of potting, &c. The pines have one peculiar advantage in this undisturbed situation; their roots grow through the bottoms of the pots, and mat among the leaves in a surprising manner. From the vigour of the plants when in this situation, it is highly probable that the leaves, even in this state, afford them an uncommon and agreeable nourishment.

"3. There is a saving in point of expence; which is no inconsiderable object in places where tan cannot be had but from a great distance.

"4. The last ground of preference is, that decayed leaves make good manure; whereas rotten tan is experimentally found to be of no value. I have often tried it both on sand and clay, and on wet and dry land; and never could discover, in any of my experiments, that it deserved the name of a manure; whereas decayed leaves are the richest, and of all others the most proper manure for a garden. Leaves mixed with dung make excellent hot-beds; and I find that beds compounded in this manner, preserve their heat much longer than when made entirely with dung; and in both cases, the application of leaves will be a considerable saving of dung, which is a circumstance on many accounts agreeable."

OAK *Saw-dust* is now found to answer the purposes of tanning as well, at least, as the bark. See TANNING.

OAK *of Jerusalem*. See CHENOPODIUM.

OAKAM, old ropes untwisted and pulled out into loose hemp, in order to be used in caulking the seams, tree-nails, and bends of a ship, for stopping or preventing leaks.

OAKHAMPTON, a town of Devonshire, which sends two members to parliament; situated in E. Long. 1. 47. N. Lat. 45. 4.

OAR, a long piece of timber, flat at one end, and round or square at the other, and which being applied to the side of a floating-vessel, serves to make it advance upon the water.

That part of the oar which is out of the vessel, and which enters into the water, is called the *blade*, or *wash*, *plat*; and that which is within-board is termed the *loom*, whose extremity being small enough to be grasped by the rowers, or persons managing the oars, is called the *handle*.

To push the boat or vessel forwards by means of this instrument, the rowers turn their backs forward, and, dipping the blade of the oar in the water, pull the handle forward so that the blade at the same time may move aft in the water: but since the blade cannot be so moved, without striking the water, this impulsion is the same, as if the water were to strike the blade from the stern towards the head: the vessel is therefore necessarily moved according to this direction. Hence it follows, that she will advance with the greater rapidity, by as much as the oar strikes the water more forcibly. Thus it is evident, that an oar acts upon the side of a boat or vessel like a lever of the second class, whose fulcrum is the station upon which the oar rests on the boat's gunnel. In large vessels, this station is usually called the *row-port*; but in lights and boats it is always termed the *row lock*.

OAT, in botany. See AVENA.

OATH, is a solemn affirmation, in which the persons sworn invoke the Almighty to witness that their testimony is true; renouncing all claim to his mercy, and calling for vengeance, if it be false.

Coronation-OATH. See KING.

OBADIAH, or the *Prophecy of* OBADIAH, a canonical book of the Old Testament, which is contained in one single chapter; and is partly an invective against the cruelty of the Ebonites, who mocked and derided the children of Israel, as they passed into captivity, and with other enemies, their confederates, invaded and oppressed those strangers, and divided the spoil amongst themselves; and partly a prediction of the deliverance of Israel, and of the victory and triumph of the whole church over her enemies.

OBELISK, in architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

Obelisks appear to be of very great antiquity, and to be first raised to transmit to posterity precepts of philosophy, which were cut in hieroglyphical characters: afterwards they were used to immortalize the great actions of heroes, and the memory of persons beloved. The first obelisk mentioned in history was that of Ramases king of Egypt, in the time of the Trojan war, which was 40 cubits high. Phius, another king of Egypt, raised one of 45 cubits: and Ptolemy Philadelphus, another of 88 cubits, in memory of Arsinoë. Augustus erected one at Rome in the Campus Martius, which served to mark the hours on an horizontal dial, drawn on the pavement. They were called by the Egyptian priests the *fingers of the sun*, because they were made in Egypt also to serve as styles or gnomons to mark the hours on the ground. The Arabs still call them *Pharaoh's needles*: whence the Italians call them *aguglia*, and the French *aiguilles*.

OBJECT, in philosophy, something apprehended or presented to the mind by sensation or imagination. See METAPHYSICS.

OBJECT-*Glass of a Telescope*, or *Microscope*, the glass placed at the end of the tube which is next the object. See OPTICS.

OBJECTION, something urged to overthrow a position, or a difficulty raised against an allegation or proposition of a person we are disputing withal.

OBJECTIVE, is used in the schools, in speaking of a thing which exists no otherwise than as an object known.

Plate CCIV.

Fig. 2.

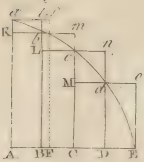


Fig. 3.

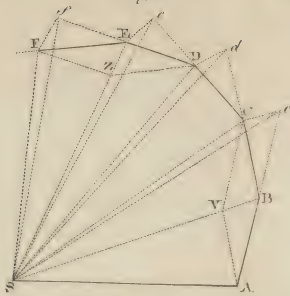
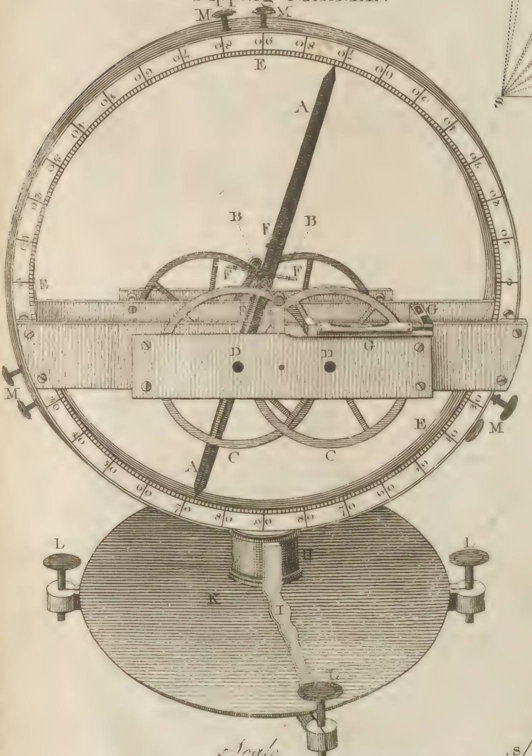


Fig. 1.

Dipping NEEDLE.



Scale

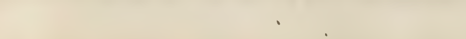
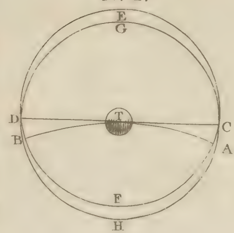


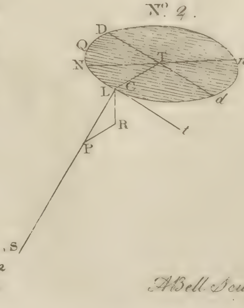
Fig. 4

NODES

N.° 1.



N.° 2.



A. Bell Sculp.t

known. The exiftence of fuch a thing is faid to be objective.

OBIT, (Lat.) fignifies a funeral folemnity, or office for the dead, moft commonly performed when the corpfe lies in the church uninterred: Alfo the anniverfary office, (2 Cro. 51 Dyer 313). The anniverfary of any perfon's death was called the *obit;* and to obferve fuch day with prayers and alms, or other commemoration, was the keeping of the obit. In religious houfes they had a regifter, wherein they entered the obits or obitual days of their founders and benefactors; which was thence termed the *obituary*. The tenure of obit or chantry lands is taken away and extinct by 1 Edw. VI. c. 14. and 15 Car. II. c. 9.

OBLATI, in church-hiftory, were fecular perfons, who devoted themfelves and their eftates to fome monaftery, into which they were admitted as a kind of lay-brothers. The form of their admiffion, was putting the bell-ropes of the church round their necks, as a mark of fervitude. They wore a religious habit, but different from that of the monks.

OBLIGATION, in general, denotes any act whereby a perfon becomes bound to another to do fomething; as to pay a fum of money, be furety, or the like.

Obligations are of three kinds, *viz.* natural, civil, and mixed. Natural obligations are entirely founded on natural equity; civil obligation, on civil authority alone, without any foundation in natural equity; and mixed obligations are thofe which, being founded on natural equity, are farther enforced by a civil authority.

In a legal fenfe, obligation fignifies a bond, wherein is contained a penalty, with a condition annexed for the payment of money, &c. The difference between it and a bill is, that the latter is generally without a penalty or condition, though it may be made obligatory: and obligations are fometimes by matter of record, as ftatutes and recognizances. See the article Bond.

Moral Obligation. See Morals, n° 36—40.

OBLIQUE, in geometry, fomething aflant, or that deviates from the perpendicular. Thus an oblique angle, is either an acute or obtufe one, *i. e.* any angle except a right one.

Oblique *Cafes*, in grammar, are all the cafes except the nominative. See Case.

Oblique *Line*, that which, falling on another line, makes oblique angles with it, *viz.* one acute, and the other obtufe.

Oblique *Planes*, in dialling, are thofe which decline from the zenith, or incline towards the horizon. See Dial.

Oblique *Sailing*, in navigation, is when a fhip fails upon fome rhumb between the four cardinal points, making an oblique angle with the meridian; in which cafe, fhe continually changes both latitude and longitude. See Navigation, §. 6.

OBLIQUUS, in anatomy, a name given to feveral mufcles, particularly in the head, eyes, and abdomen. See Anatomy, *Table of the Mufcles*.

OBLONG, in general, denotes a figure that is longer than broad: fuch is a parallellogram, ellipfis, &c.

OBOLUS, an ancient filver money of Athens, the

fixth part of a drachma; worth fomewhat more than penny-farthing Sterling.—The word comes from the Greek ὀϐολὸς, of ὀϐελὸς, "fpit, or broach;" either becaufe it bore fuch an impreffion; or becaufe, according to Euftachius, it was in form thereof. But thofe now in the cabinets of the antiquaries are round.

Obolus, in medicine, is ufed for a weight of ten grains, or half a fcruple.

OBRECHT (Ulric), a learned German, born of a noble family at Strafburg in 1646, where he filled the chairs of civil law and hiftory with great diftinction. He was of the Proteftant religion; but when Lewis XIV. made himfelf mafter of Strafburg, and went there with his court, he was prevailed on to change; and accordingly abjured in 1684, and put his inftrument into the hands of Boffuet bifhop of Meaux. The next year the king nominated him to prefide in his name in the fenate of Strafburg, with the title of prætor royal, in imitation of the ancient Romans; from which time Mr Obrecht applied himfelf entirely to public affiairs. He was the editor, tranflator, and writer, of feveral learned works; and died in 1701.

OBREPTITIOUS, an appellation given to letters patent, or other inftruments, obtained of a fuperior by furprife, or by concealing from him the truth.

OBSCURE, fomething that is dark and reflects little light, or that is not clear and intelligible.

OBSECRATION, in rhetoric, a figure whereby the orator implores the affiftance of God or man.

OBSEQUENS (Julius), a Latin writer, conjectured to have lived before the emperor Honorius's reign. He made a collection of the prodigies which Livy related in his hiftory. There are feveral editions of thofe remains. Lycofthenes endeavoured to fupply what was wanting in the original.

OBSEQUIES, the fame with funeral folemnities. See Funeral.

OBSERVATION, among navigators, fignifies the taking the fun's or the ftars meridian altitude, in order thereby to find the latitude.

OBSERVATORY, a place deftined for obferving the heavenly bodies; being generally a building erected on fome eminence, covered with a terrace for making aftronomical obfervations.

The more celebrated obfervatories are, 1. The Greenwich obfervatory, built in 1676, by order of Charles II. at the folicitation of Sir Jonas Moore and Sir Chriftopher Wren; and furnifhed with the moft accurate inftruments, particularly a noble fextant of feven feet radius, with telefcopic fights.

2. The Paris obfervatory, built by the order of Louis XIV. in the Fauxbourg, St Jaques.

It is a very fingular, but withal a very magnificent building, the defign of Monfieur Perault: it is eighty feet high; and at top is a terrace.

The difference in longitude between this and the Greenwich obfervatory is 2° 20′ weft.

In it is a cave, or cellar, of 170 feet defcent, for experiments that are to be made far from the fun, &c. particularly fuch as relate to congelations, refrigerations, indurations, confervations, &c.

3. Tycho Brahe's obfervatory, which was in the little ifland Ween, or Scarlet Ifland, between the coafts of Schonen and Zealand, in the Baltic. It was erected and furnifhed with inftruments at his own ex-

pence, and called by him *Uraniburg*. Here he fpent twenty years in obferving the ftars; the refult is his catalogue.

4. Pekin obfervatory. Father Le Compte defcribes a very magnificent obfervatory, erected and furnifhed by the late emperor of China, in his capital, at the interceffion of fome Jefuit miffionaries, principally Father Verbeift, whom he made his chief obferver.—The inftruments are exceedingly large; but the divifion lefs accurate, and the contrivance in fome refpects lefs commodious, than that of the Europeans. The chief are, An armillary zodiacal fphere of fix feet diameter; an equinoctial fphere of fix feet diameter; an azimuthal horizon of fix feet diameter; a large quadrant fix feet radius; a fextant eight feet radius; and a celeftial globe fix feet diameter.

5. Bramins obfervatory at Benares. Of this Sir Robert Barker gives the following account, Phil. Tranf. Vol. LXVII. p. 598. " Benares in the Eaft Indies, one of the principal feminaries of the Bramins or priefts of the original Gentoos of Hindoftan, continues ftill to be the place of refort of that fect of people; and there are many public charities, hofpitals, and pagodas, where fome thoufands of them now refide. Having frequently heard that the ancient Bramins had a knowledge of aftronomy, and being confirmed in this by their information of an approaching eclipfe both of the fun and moon, I made inquiry, when at that place in the year 1772, among the principal Bramins, to endeavour to get fome information relative to the manner in which they were acquanted of an approaching eclipfe. The moft intelligent that I could meet with, however, gave me but little fatisfaction. I was told, that thefe matters were confined to a few, who were in poffeffion of certain books and records; fome containing the myfteries of their religion; and others the tables of aftronomical obfervations, written in the Skanfkirrit language, which few underftood but themfelves: that they would take me to a place which had been conftructed for the purpofe of making fuch obfervations as I was inquiring after, and from whence they fuppofed the learned Bramins made theirs. I was then conducted to an ancient building of ftone, the lower part of which, in its prefent fituation, was converted into a ftable for horfes, and a receptacle for lumber; but, by the number of court-yards and apartments, it appeared that it muft once have been an edifice for the ufe of fome public body of people. We entered this building, and went up a ftair-cafe to the top of a part of it, near to the river Ganges, that led to a large terrace, where, to my furprife and fatisfaction, I faw a number of inftruments yet remaining, in the greateft prefervation, ftupendoufly large, immoveable from the fpot, and built of ftone, fome of them being upwards of 20 feet in height; and, although they are faid to have been erected 200 years ago, the graduations and divifions on the feveral arcs appeared as well cut, and as accurately divided, as if they had been the performance of a modern artift. The execution in the conftruction of thefe inftruments exhibited a mathematical exactnefs in the fixing, bearing, fitting of the feveral parts, in the neceffary and fufficient fupports to the very large ftones that compofed them, and in the joining and faftening each into the other by means of lead and iron.

" The fituation of the two large quadrants of the inftrument marked A in the plate, whofe radius is nine feet two inches, by their being at right angles with a gnomon at twenty-five degrees elevation, are thrown into fuch an oblique fituation as to render them the moft difficult, not only to conftruct of fuch a magnitude, but to fecure in their pofition for fo long a period, and affords a ftriking inftance of the ability of the architect in their conftruction: for, by the fhadow of the gnomon thrown on the quadrants, they do not appear to have altered in the leaft from their original pofition; and fo true is the line of the gnomon, that, by applying the eye to a fmall iron ring of an inch diameter at one end, the fight is carried through three others of the fame dimenfion, to the extremity at the other end, diftant 38 feet 8 inches, without obftruction; fuch is the firmnefs and art with which this inftrument has been executed. This performance is the more wonderful and extraordinary when compared with the works of the artificers of Hindoftan at this day, who are not under the immediate direction of an European mechanic; but arts appear to have declined equally with fcience in the eaft.

Plate CCV.

" Lieutenant-colonel Archibald Campbell, at that time chief engineer in the Eaft India Company's fervice at Bengal, made a perfpective drawing of the whole of the apparatus that could be brought within his eye at one view; but I lament he could not reprefent fome very large quadrants, whofe radii were about twenty feet, they being on the fide from whence he took his drawing. Their defcription however is, that they are exact quarters of circles of different radii, the largeft of which I judged to be 20 feet, conftructed very exactly on the fides of ftone-walls built perpendicular, and fituated, I fuppofe, in the meridian of the place: a brafs pin is fixed at the centre or angle of the quadrant, from whence, the Bramin informed me, they ftretched a wire to the circumference when an obfervation was to be made; from which it occurred to me, the obferver muft have moved his eye up or down the circumference, by means of a ladder or fome fuch contrivance, to raife and lower himfelf, until he had difcovered the altitude of any of the heavenly bodies in their paffage over the meridian, fo expreffed on the arcs of thefe quadrants: thefe arcs were very exactly divided into nine large fections; each of which again into ten, making ninety leffer divifions or degrees; and thofe alfo into twenty, expreffing three minutes each, of about two-tenths of an inch afunder; fo that it is probable, they had fome method of dividing even thefe into more minute divifions at the time of obfervation.

" My time would only permit me to take down the particular dimenfions of the moft capital inftrument, or the greater equinoctial fun-dial, reprefented by figure A, which appears to be an inftrument to exprefs folar time by the fhadow of a gnomon upon two quadrants, one fituated to the eaft, and the other to the weft of it; and indeed the chief part of their inftruments at this place appear to be conftructed for the fame purpofe, except the quadrants, and a brafs inftrument that will be defcribed hereafter.

" Figure B is another inftrument for the purpofe of determining the exact hour of the day by the fhadow

dow of a gnomon, which ftands perpendicular to and in the centre of a flat circular ftone, fupported in an oblique fituation by means of four upright ftones and a crofs-piece ; fo that the fhadow of the gnomon, which is a perpendicular iron rod, is thrown upon the divifion of the circle defcribed on the face of the flat circular ftone.

"Figure C is a brafs circle, about two feet diameter, moving vertically upon two pivots between two ftone pillars, having an index or hand turning round horizontally on the centre of this circle, which is divided into 360 parts ; but there are no counter divifions on the index to fubdivide thofe on the circle. This inftrument appears to be made for taking the angle of a ftar at fetting or rifing, or for taking the azimuth or amplitude of the fun at rifing or fetting.

"The ufe of the inftrument, figure D, I was at a lofs to account for. It confifts of two circular walls; the outer of which is about forty feet diameter, and eight feet high ; the wall within about half that height, and appears intended for a place to ftand on to obferve the divifions on the upper circle of the outer wall, rather than for any other purpofe ; and yet both circles are divided into 360 degrees, each degree being fubdivided into twenty leffer divifions, the fame as the quadrants. There is a door-way to pafs into the inner circle, and a pillar in the centre, of the fame height with the lower circle, having a hole in it, being the centre of both circles, and feems to be a focket for an iron rod to be placed perpendicular into it. The divifions on thefe, as well as all the other inftruments, will bear a nice examination with a pair of compaffes.

"Figure E is a fmaller equinoctial fun-dial, conftructed upon the fame principle as the large one A.

"I cannot quit this fubject without obferving, that the Bramins, without the affiftance of optical glaffes, had neverthelefs an advantage unexperienced by the obfervers of the more northern climates. The ferenity and clearnefs of the atmofphere in the nighttime in the Eaft Indies, except at the feafons of changing the monfoons or periodical winds, is difficult to exprefs to thofe who have not feen it, becaufe we have nothing in comparifon to form our ideas upon : it is clear to perfection, a total quietude fubfifts, fcarcely a cloud to be feen, and the light of the heavens, by the numerous appearance of the ftars, affords a profpect both of wonder and contemplation.

"This obfervatory at Benares is faid to have been built by the order of the emperor Ackbar: for as this wife prince endeavoured to improve the arts, fo he wifhed alfo to recover the fciences of Hindoftan, and therefore directed that three fuch places fhould be erected ; one at Delhi, another at Agra, and the third at Benares."

Edinburgh OBSERVATORY. See EDINBURGH.

OBSIDIANUS LAPIS, in the natural hiftory of the ancients, the name of a ftone which they have alfo defcribed under the name of the *Chian marble*. It is a very fmooth and hard marble, extremely difficult to cut, but capable of a fine polifh ; and was ufed among the ancient Greeks for the purpofe of making reflecting mirrors. The later writers have fuppofed the name *obfidianus* to be derived from fomebody called *Obfidius*, who was the inventor of this ufe of it; but it feems only a falfe fpelling of the word *opfianus*, απο της οψεως, from feeing the images of things in it.

OBSIDIONALIS, an epithet applied by the Romans to a fort of crown. See the article CROWN.

OBSTETRICS, or the OBSTETRIC ART, the fame with MIDWIFERY.

OBSTRUCTION, in medicine, fuch an obturation of the veffels as prevents the circulation of the fluids, whether of the found and vital, or of the morbid and peccant kind, through them.

OBTURATOR, in anatomy. See ANATOMY, *Table of the Mufcles*.

OBTUSE, fignifies blunt, dull, &c. in oppofition to acute or fharp. Thus we fay, obtufe angle ; obtufe angled triangle, &c.

OBY, or OB, a river of the Ruffian empire in Afia, which rifes in the defart of Ifchinfka, and, running north, joins the Irtis near Tobolfk ; and, ftill keeping its name, continues its courfe north, and falls into a deep bay called *Obfkaya*, in about 63 degrees of latitude. The exact courfe of this river was unknown, till the country was furveyed by the Ruffians ; who have given us good maps of it and of all Siberia. The Oby forms the boundary between Europe and Afia, and its courfe is upwards of 2000 miles in length.

OCCIDENT, in geography, the weftward quarter of the horizon ; or that part of the horizon where the ecliptic, or the fun therein, defcends into the lower hemifphere; in contradiftinction to *orient*. Hence we ufe the word *occidental* for any thing belonging to the weft ; as occidental bezoar, occidental pearl, &c.

OCCIPITAL, in anatomy, a term applied to the parts of the occiput, or back part of the fkull.

OCCULT, fomething hidden, fecret, or invifible. The occult fciences are magic, necromancy, cabbala, &c.

OCCULT, in geometry, is ufed for a line that is fcarce perceivable, drawn with the point of the compaffes or a leaden pencil. Thefe lines are ufed in feveral operations, as the raifing of plans, defigns of building, pieces of perfpective, &c. They are to be effaced when the work is finifhed.

OCCULTATION, in aftronomy, the time a ftar or planet is hid from our fight, by the interpofition of the body of the moon or fome other planet.

OCCUPANCY, in law, is the taking poffeffion of thofe things which before belonged to nobody. This is the true ground and foundation of all PROPERTY, or of holding thofe things in feveralty, which by the law of nature, unqualified by that of fociety, were common to all mankind. But, when once it was agreed that every thing capable of ownerfhip fhould have an owner, natural reafon fuggefted, that he who could firft declare his intention of appropriating any thing to his own ufe, and, in confequence of fuch his intention, actually took it into poffeffion, fhould thereby gain the abfolute property of it; according to that rule of the law of nations, recognized by the laws of Rome, *quod nullius eft, id ratione naturali occupanti conceditur*. *Blackft. Comment.*

Occupancy. This right of occupancy, ſo far as it concerns real property, hath been confined by the laws of England within a very narrow compaſs; and was extended only to a ſingle inſtance; namely, where a man was tenant *pour autre vie*, or had an eſtate granted to himſelf only (without mentioning his heirs) for the life of another man, and died during the life of *ceſtuy que vie*, or him by whoſe life it was holden: in this caſe, he that could firſt enter on the land, might lawfully retain the poſſeſſion ſo long as *ceſtuy que vie* lived, by right of occupancy.

This ſeems to have been recurring to firſt principles, and calling in the law of nature to aſcertain the property of the land, when left without a legal owner, For it did not revert to the grantor; who had parted with all his intereſt, ſo long as *ceſtuy que vie* lived: it did not eſcheat to the lord of the fee; for all eſcheats muſt be of the abſolute entire fee, and not of any particular eſtate carved out of it; much leſs of ſo minute a remnant as this: it did not belong to the grantee; for he was dead: it did not deſcend to his heirs; for there were no words of inheritance in the grant: nor could it veſt in his executors; for no executors could ſucceed to a freehold. Belonging therefore to nobody, like the *hæreditas jacens* of the Romans, the law left it open to be ſeiſed and appropriated by the firſt perſon that could enter upon it, during the life of *ceſtuy que vie*, under the name of an occupant. But there was no right of occupancy allowed, where the king had the reverſion of the lands: for the reverſioner hath an equal right with any other man to enter upon the vacant poſſeſſion; and where the king's title and a ſubject's interfere, the king's ſhall always be preferred. Againſt the king therefore there could be no prior occupant, becauſe *nullum tempus occurrit regi.* And, even in the caſe of a ſubject, had the eſtate *pour autre vie* been granted to a man *and his heirs* during the life of *ceſtuy qui vie*, there the heir might, and ſtill may, enter and hold poſſeſſion, and is called in law a *ſpecial occupant;* as having a ſpecial excluſive right, by the terms of the original grant, to enter upon and occupy this *hæreditas jacens*, during the reſidue of the eſtate granted: though ſome have thought him ſo called with no very great propriety; and that ſuch eſtate is rather a deſcendible freehold. But the title of *common occupancy* is now reduced almoſt to nothing by two ſtatutes; the one, 29 Car. II. c. 3. which enacts, that where there is no ſpecial occupant, in whom the eſtate may veſt, the tenant *pour autre vie* may deviſe it by will, or it ſhall go to the executors and be aſſets in their hands for payment of debts: the other that of 14 Geo. II. c. 20. which enacts, that it ſhall veſt not only in the executors, but, in caſe the tenant dies inteſtate, in the adminiſtrators alſo; and go in courſe of a diſtribution like a chattel intereſt.

By theſe two ſtatutes the title of *common occupancy* is utterly extinct and aboliſhed: tho' that of *ſpecial occupancy*, by the heir at law, continues to this day; ſuch heir being held to ſucceed to the anceſtor's eſtate, not by deſcent, for then he muſt take an eſtate of inheritance, but as an occupant, ſpecially marked out and appointed by the original grant. The doctrine of common occupancy may, however, be uſefully remembered on the following account, amongſt others: That, as by the common law no occupancy could be of incorporeal hereditaments, as of rents, tithes, advowſons, commons, Occupancy. or the like, (becauſe, with reſpect to them, there could be no actual entry made, or corporal ſeiſin had; and therefore by the death of the grantee *pour autre vie* a grant of ſuch hereditaments was entirely determined): ſo now, it is apprehended, notwithſtanding thoſe ſtatutes, ſuch grant would be determined likewiſe; and the hereditaments could not be deviſeable, nor veſt in the executors, nor go in a courſe of diſtribution. For the ſtatutes muſt not be conſtrued ſo as to create any new eſtate, or to keep that alive which by the common law was determined, and thereby to defeat the grantor's reverſion; but merely to diſpoſe of an intereſt in being, to which by law there was no owner, and which therefore was left open to the firſt occupant. When there is a reſidue left, the ſtatutes give it to the executors, &c. inſtead of the firſt occupant; but they will not create a reſidue, on purpoſe to give it to the executors. They only mean to provide an appointed inſtead of a caſual, a certain inſtead of an uncertain, owner, of lands which before were nobody's; and thereby to ſupply this *caſus omiſſus*, and render the diſpoſition of the law in all reſpects entirely uniform: this being the only inſtance wherein a title to a real eſtate could ever be acquired by occupancy.

For there can be no other caſe deviſed, wherein there is not ſome owner of the land appointed by the law. In the caſe of a ſole corporation, as a parſon of a church, when he dies or reſigns, though there be no *actual* owner of the land till a ſucceſſor be appointed, yet there is a *legal, potential* ownerſhip, ſubſiſting in contemplation of law; and when the ſucceſſor is appointed, his appointment ſhall have a retroſpect and relation backwards, ſo as to entitle him to all the profits from the inſtant that the vacancy commenced. And, in all other inſtances, when the tenant dies inteſtate, and no other owner of the lands is to be found in the common courſe of deſcents, there the law veſts an ownerſhip in the king, or in the ſubordinate lord of the fee, by eſcheat.

So alſo, in ſome caſes, where the laws of other nations give a right by occupancy, as in lands newly created, by the riſing of an iſland in a river, or by the alluvion or dereliction of the ſea; in theſe inſtances, the law of England aſſigns them an immediate owner. For Bracton tells us, that if an iſland ariſe in the *middle* of a *river*, it belongs in common to thoſe who have lands on each ſide thereof; but if it be nearer to one bank than the other, it belongs only to him who is proprietor of the neareſt ſhore: which is agreeable to, and probably copied from, the civil law. Yet this ſeems only to be reaſonable, where the ſoil of the river is equally divided between the owners of the oppoſite ſhores: for if the whole ſoil is the freehold of any one man, as it muſt be whenever a ſeveral fiſhery is claimed, there it ſeems juſt (and ſo is the uſual practice) that the iſlets, or little iſlands, ariſing in any part of the river, ſhall be the property of him who owneth the piſcary and the ſoil. However, in caſe a new iſland riſe in the *ſea*, though the civil law gives it to the firſt occupant, yet our's gives it to the king. And as to lands gained from the ſea; either by *alluvion*, by the waſhing up of ſand and earth, ſo as in time to make *terra firma;* or by *dereliction*, as when the ſea ſhrinks back below the uſual water-mark; in theſe

these cases the law is held to be, that if this gain be by little and little, by small and imperceptible degrees, it shall go to the owner of the land adjoining. For *de minimis non curat lex:* and, besides, these owners being often losers by the breaking in of the sea, or at charges to keep it out, this possible gain is therefore a reciprocal consideration for such possible charge or loss. But if the alluvion or dereliction be sudden and considerable, in this case it belongs to the king: for, as the king is lord of the sea, and so owner of the soil while it is covered with water, it is but reasonable he should have the soil when the water has left it dry. So that the quantity of ground gained, and the time during which it is gained, are what make it either the king's or the subject's property. In the same manner, if a river, running between two lordships, by degrees gains upon the one, and thereby leaves the other dry; the owner who loses his ground thus imperceptibly has no remedy: but if the course of the river be changed by a sudden and violent flood, or other hasty means, and thereby a man loses his ground, he shall have what the river has left in any other place, as a recompence for this sudden loss. And this law of alluvions and derelictions, with regard to *rivers*, is nearly the same in the imperial law; from whence indeed those our determinations seem to have been drawn and adopted: but we ourselves, as islanders, have applied them to *marine* increases; and have given our sovereign the prerogative he enjoys, as well upon the particular reasons before-mentioned, as upon this other general ground of prerogative, which was formerly remarked, that whatever hath no other owner is vested by law in the king. See PREROGATIVE.

OCCUPANT, in law, the person that first seizes or gets possession of a thing.

OCCUPATION, in a legal sense, is taken for use or tenure; as in deeds it is frequently said, that such lands are, or were lately, in the tenure of occupation of such a person.—It is likewise used for a trade or mystery.

OCCUPIERS *of* WALLING, a term used in the salt-works for the persons who are the sworn officers that allot in particular places what quantity of salt is to be made, that the markets may not be overstocked, and see that all is carried fairly and equally between the lord and the tenant.

OCEAN, in geography, that vast collection of salt and navigable waters, in which the two continents, the first including Europe, Asia, and Africa, and the last America, are inclosed like islands.

The ocean is distinguished into three grand divisions. 1. The Atlantic ocean, which divides Europe and Africa from America, which is generally about 3000 miles wide. 2. The Pacific ocean, or South-sea, which divides America from Asia, and is generally about 10,000 miles over. And, 3. The Indian ocean, which separates the East Indies from Africa; which is 3000 miles over. The other seas, which are called *oceans*, are only parts or branches of these, and usually receive their names from the countries they border upon.

For the saltness, tides, &c. of the ocean, see the articles SEA, TIDES, &c.

OCEANUS, in Pagan mythology, the son of Cælus and Terra, the husband of Thetis, and the father of the Rivers and Fountains. The ancients called him the *Father of all things*, imagining that he was produced by Humidity, which, according to Thales, was the first principle from which every thing was produced. Homer represents Juno visiting him at the remotest limits of the earth, and acknowledging him and Thetis as the parents of the gods. He was represented with a bull's head, as an emblem of the rage and bellowing of the ocean when agitated by a storm.

OCELLUS *the* LUCANIAN, an ancient Greek philosopher of the school of Pythagoras, who lived before Plato. His work περι τυ Παντος, or "the Universe," is the only piece of his which is come down entire to us; and was written originally in the Dorci dialect, but was translated by another hand into the Attic. William Christian, and after him Lewis Nogarola, translated this work into Latin; and we have several editions of it, both in Greek and Latin.

OCHLOCRACY, that form of government wherein the populace have the chief administration of affairs.

OCHRE, in natural history, a genus of earths, slightly coherent, and composed of fine, smooth, soft, argillaceous particles, rough to the touch, and readily diffusible in water. Ochres are of various colours, as red, blue, yellow, brown, green, &c.

OCKLEY (Simon), a learned orientalist, was born at Exeter, in 1678, and educated at Queen's college, Cambridge, where he distinguished himself by his intense application to literature. At the usual time he took the degrees in arts, and that of bachelor in divinity; but marrying very young, was precluded from a fellowship in his college, and this occasioned his being afterwards involved in many difficulties. In 1705, he was presented to the vicarage of Swavesey in Cambridgeshire; and in 1711, he was chosen Arabic professor of the university; but afterwards had the misfortune to be confined for some time in Cambridge-castle for debt. The above preferments, however, he enjoyed till his death, which happened on the 9th of August 1720. He wrote, 1. *Introductio ad Linguas Orientales*. 2. The history of the present Jews throughout the world; translated from the Italian of Leo Modena, a Venetian rabbi. 3. The improvement of human reason, exhibited in the life of Hai Ebn Yokdhan, translated from the Arabic. 4. An account of South-west Barbary, containing what is most remarkable in the kingdoms of Fez and Morocco; written by a person who had been a slave there a considerable time, and translated from his manuscript. 5. The history of the Saracens, collected from the most authentic Arabic authors, in 2 vols 8vo. He was not only well skilled in the learned languages; but also in the modern, as French, Spanish, Italian, &c.

OCTAETARIDES, in chronology, denotes a cycle of eight years, at the end of which three entire lunar months were added. This cycle was used at Athens till Meton discovered the golden number.

OCTAGON, or OCTOGON, in geometry, is a figure of eight sides and angles; and this, when all the sides and angles are equal, is called a *regular octagon*, or one that may be inscribed in a circle.

OCTAGON, in fortification, denotes a place that has eight bastions. See FORTIFICATION.

OCTAHEDRON, or OCTAEDRON, in geometry, one

one of the five regular bodies, consisting of eight equal and equilateral triangles.

OCTANDRIA (οκτω, "eight," and ανηρ, a "man, or husband,") the eighth class in Linnæus sexual system; consisting of plants with hermaphrodite flowers, which are furnished with eight stamina, or male organs of generation. See BOTANY, p. 1292.

OCTANT, or OCTILE, in astronomy, that aspect of two planets, wherein they are distant an eighth part of a circle, or 45°, from each other.

OCTAPLA, in matters of sacred literature, denotes a polyglot bible, consisting of eight columns, and as many different versions of the sacred text; viz. the original Hebrew both in Hebrew and Greek characters, Greek versions, &c.

OCTATEUCH, an appellation given to the eight first books of the Old Testament.

OCTAVE, in music. See INTERVAL.

OCTOBER, in chronology, the tenth month of the Julian year, consisting of 31 days; it obtained the name of *October*, from its being the eighth month in the kalendar of Romulus.

OCTOSTYLE, in the ancient architecture, is the face of an edifice adorned with eight columns.

OCULUS, the EYE, in anatomy. See there, n° 406.

OCULUS *Beli*, in natural history, one of the semi-pellucid gems, of a greyish white colour, variegated with yellow, and with a black central nucleus: it is of a roundish form, and its variegations very beautifully represent the pupil and iris of the eye; whence the name.

OCULUS *Cati*. See ASTERIA.

OCULUS *Mundi*, one of the semi-pellucid gems, of a whitish-grey colour, without any variegations.

OCYMUM, BASIL; a genus of the gynospermia order, belonging to the didynamia class of plants. There are eight species, all of them natives of warm climates, rising from six inches to two feet in height, and having a strong aromatic smell, resembling that of cloves. One of the species is used in the kitchen, particularly by the French cooks, who make great use of it in their soups and sauces. This rises about ten inches high, sending out branches by pairs opposite, from the bottom; the stalks and branches are four-cornered; the leaves are oval, spear-shaped, ending in acute points, and are indented on their edges; the whole plant is hairy, and has a strong scent of cloves too powerful for most persons, but to some it is very agreeable. These plants are propagated by seeds, and will thrive in this country in the open air, and will even ripen their seeds if placed in a stove or airy glass-case.

OCZAKOW, or OCZAKOFF, a town of Turky in Europe, and capital of a Sangiack of the same name, inhabited by Tartars. During a late war, here was a Turkish garrison of 20,000 men. However, it was taken by the Russians in 1737, and all those that resisted were put to the sword. The Russians themselves lost 18,000 men in the assault. The Turks returned the same year with 70,000 men to retake it; but were obliged to retire, after the loss of 20,000. In 1738, the Russians withdrew their garrison, and demolished the fortifications. It is seated on the river Bog, to the west of the Nieper, or rather where they both unite and fall into the Black Sea. It is 42 miles south-west of Bialagrod, and 190 north by east of Constantinople. E. Long. 30. 0. N. Lat. 46. 30.

ODA, in the Turkish seraglio, signifies a class, order, or chamber. The grand signior's pages are divided into five classes or chambers. The first, which is the lowest in dignity, is called the *great oda*, from the great number of persons that compose it: these are the juniors, who are taught to read, write, and speak the languages. The second is called the *little oda*, where, from the age of 14 or 15 years, till about 20, they are trained up to arms, and the study of all the polite learning the Turks are acquainted with. The third chamber, called *kilar oda*, consists of 200 pages, which, besides their other exercises, are under the command of the kilardgi-bachi, and serve in the pantry and fruitery. The fourth consists only of 24, who are under the command of the khazineda-bachi, and have charge of the treasure in the grand signior's apartment, which they never enter with cloaths that have pockets. The fifth is called *kas-oda*, or *privy-chamber*; a•d is composed of only 40 pages who attend in the prince's chamber. Every night eight of these pages keep guard in the grand signior's bed-chamber, while he sleeps: they take care that the light, which is constantly kept in the room, does not glare in his eyes, lest it should awake him; and if they find him disturbed with troublesome dreams, they cause him to be awaked by one of their agas.

ODA-*Bachi*, or *Oddobassi*, among the Turks, an officer equivalent to a serjeant or corporal among us.

ODE, in poetry, a song, or composition proper to be sung. See POETRY.

ODENSEE, a considerable town of Denmark, in the Isle of Funen, with a bishop's see. E. Long. 10. 27. N. Lat. 55. 28.

ODER, a river of Germany, which has its source near a town of the same name in Silesia, and on the confines of Moravia. It runs north through that province, and then into the Marche of Brandenburg and Pomerania, where it forms a large lake, afterwards falling into the Baltic Sea by three mouths; between which lie the islands Usedom and Wolin. It passes by several towns; as Ratibor, Oppelen, Breslau, Glogau, and Crossen, in Silesia; Francfort, Lebus, and Custrin, in Brandenburg; and Gartz, Stetin, Cammin, Wallin, Usedom, and Wolgast, in Pomerania.

ODEUM, in Grecian antiquity, a music-theatre, built by Pericles; the inside of which was filled with seats and ranges of pillars, and on the outside the roof descended shelving downwards from a point in the centre, with many bendings, in imitation of the king of Persia's pavilion. Here the musical prizes were contended for; and here also, according to Aristophanes, was a tribunal.

De ODIO *et Atia*. See *False* IMPRISONMENT.

The writ *de odio et atia* was anciently used to be directed to the sheriff, commanding him to inquire whether a prisoner charged with murder was committed upon just cause of suspicion, or merely *propter odium et atiam*, for hatred and ill-will; and if upon the inquisition due cause of suspicion did not then appear, then there issued another writ for the sheriff to admit him to bail. This writ, according to Bracton, ought not to be denied to any man; it being expressly ordered

to be made out *gratis*, without any denial, by *magna carta*, c. 26. and ſtatute Weſtm. 2. 13 Edw. I. c. 29. But the ſtatute of Gloceſter, 6 Edw. I. c. 9. reſtrained it in the caſe of killing by miſadventure or ſelf-defence, and the ſtatute 28 Edw. III. c. 9. aboliſhed it in all caſes whatſoever: but as the ſtat. 42 Ed. III. c. 1. repealed all ſtatutes then in being, contrary to the great charter, Sir Edward Coke is of opinion that the writ *de odio et atia* was thereby revived. See HABEAS *Corpus*.

ODO (St), ſecond abbot of Clugni in France, was illuſtrious for learning and piety in the 10th century. The ſanctity of his life contributed greatly to enlarge the congregation of Clugni; and he was ſo eſteemed, that popes, biſhops, and ſecular princes, uſually choſe him the arbiter of their diſputes. He died about the year 942, and his works are printed in the Bibliotheque of Clugni.

ODO *Cantianus*, ſo called as being a native of Kent, in England, was a Benedictine monk in the 12th century, in which order his learning and eloquence raiſed him to the dignity of prior and abbot. Archbiſhop Becket was his friend, and his panegyric was made by John of Saliſbury. He compoſed Commentaries on the Pentateuch, and the Second Book of Kings; Moral Reflections on the Pſalms; treatiſes intitled, *De onere Philiſtim; De moribus Eccleſiaſticis; De vitiis et virtutibus Animæ*, &c.

ODONTALGIA, the TOOTHACH. See MEDICINE, n° 314. and p. 4869.

ODONTOIDE, in anatomy, an appellation given to the proceſs of the ſecond vertebra of the neck, from its reſemblance to a tooth.

ODOROUS, or ODORIFEROUS, appellations given to whatever ſmells ſtrongly, whether they be fetid or agreeable; but chiefly to things whoſe ſmell is briſk and agreeable.

ODYSSEY, a celebrated epic poem of Homer, wherein are related the adventures of Ulyſſes in his return from the ſiege of Troy.

OECONOMICS, the art of managing the affairs of a family, or community; and hence the perſon who takes care of the revenues and other affairs of churches, monaſteries, and the like, is termed *œconomus*.

OECONOMY, denotes the prudent conduct, or diſcreet and frugal management, whether of a man's own eſtate, or that of another.

Animal OECONOMY, comprehends the various operations of nature in the generation, nutrition, and preſervation of animals †. The doctrine of the animal œconomy is nearly connected with phyſiology, which explains the ſeveral parts of the human body, their ſtructure, uſe, &c. See ANATOMY and MEDICINE.

† See *Generation*, *Nutrition*, &c.

OECUMENICAL, ſignifies the ſame with *general* or *univerſal;* as, œcumenical council, biſhop, &c.

OEDEMA, or PHLEGMATIC TUMOUR, in medicine and ſurgery, a ſort of tumour attended with paleneſs and cold, yielding little reſiſtance, retaining the print of the finger when preſſed with it, and accompanied with little or no pain.

This tumour obtains no certain ſituation in any particular part of the body, ſince the head, eye-lids, hands, and ſometimes part, ſometimes the whole body, is afflicted with it. When the laſt mentioned is the caſe, the patient is ſaid to be troubled with a cachexy, leucophlegmatia, or dropſy. But if any particular part is more ſubject to this diſorder than another, it is certainly the feet, which are at that time called *ſwelled* or *œdematous feet*.

OEDIPUS, the unfortunate king of Thebes, whoſe hiſtory is partly fabulous, flouriſhed about 1266 B. C. It is ſaid he was given by his father to a ſhepherd, who was ordered to put him to death, in order to prevent the misfortunes with which he was threatened by an oracle. But the ſhepherd being unwilling to kill him with his own hands, tied him by the feet to a tree, that he might be devoured by wild beaſts. The infant was, however, found in this ſituation by another ſhepherd named *Phorbas*, who carried him to Polybus king of Corinth; where the queen, having no children, educated him with as much care as if he had been her ſon. When he was grown up, he was informed that he was not the ſon of Polybus: on which, by order of the oracle, he went to ſeek for his father in Phocis; but ſcarce was he arrived in that country, when he met his father on the road, and killed him without knowing him. A ſhort time after, having delivered the country from the monſter called the *Sphinx*, he married Jocaſta, without knowing that ſhe was his mother, and had four children by her; but afterwards being informed of his inceſt, he quitted the throne, and, thinking himſelf unworthy of the light, put out his eyes. Eteocles and Polynices, who were celebrated amongſt the Greeks, were born of this inceſtuous marriage.

OELAND, an iſland of Sweden, ſeated on the Baltic ſea, between the continent of Gothland and the iſle of Gothland, in between 56° and 57° of north latitude, and between 17° and 18° of eaſt longitude. It is about 60 miles in length, and 15 in breadth; having a wholeſome air, and a fertile ſoil, with riſing hills, and ſeveral caſtles. It has no town of any great note.

OENANTHE, WATER DROPWORT; a genus of the digynia order, belonging to the pentandria claſs of plants. There are five ſpecies; of which the moſt remarkable is the crocata, or hemlock dropwort, growing frequently on the banks of ditches, rivers, and lakes, in many parts of Britain. The roots and leaves of this plant are a terrible poiſon; ſeveral perſons have periſhed by eating it through miſtake, either for water-parſnips or for celery, which laſt it reſembles pretty much in its leaves. So exceedingly deleterious is this plant, that Mr Lightfoot tells us, he has heard the late Mr Chriſtopher d'Ehret, the celebrated botanic painter, ſay, that while he was drawing it, the ſmell or effluvia only rendered him ſo giddy, that he was ſeveral times obliged to quit the room, and walk out in the freſh air to recover himſelf; but recollecting at laſt what might be the probable cauſe of his repeated illneſs, he opened the door and windows of the room, and the free air then enabled him to finiſh his work without any more returns of the giddineſs. Mr Lightfoot informs us, that he has given a ſpoonful of the juice of this plant to a dog, but without any other effect than that of making him very ſick and ſtupid. In about an hour he recovered; and our author has ſeen a goat eat it with impunity. To ſuch of the human ſpecies as have unfortunately eat any part of this plant, a vomit is the

moſt

moſt approved remedy.

OENOPTÆ, in Grecian antiquity, a kind of cenſors at Athens, who regulated entertainments, and took care that none drank too much, nor too little.

OENOTHERA, TREE-PRIMROSE; a genus of the monogynia order, belonging to the octandria claſs of plants. There are ſeven ſpecies; the moſt remarkable of which are,

1. The biennis, or common biennial tree-primroſe. It hath a long, thick, deeply-ſtriking root; crowned with many large, oval, ſpear-ſhaped, plane, ſpreading leaves; upright, thick, firm, rough, hairy ſtems, riſing three or four feet high; garniſhed with long, narrow, lanceolate, cloſe-fitting leaves, irregularly; and at all the axillas, from the middle upwards, large bright-yellow flowers.

2. Octovalvis, or octovalved, ſmooth, biennial tree-primroſe, hath upright, firm, ſomewhat hairy ſtems, riſing a yard high; oblong, ſpear-ſhaped, pointed, plane, ſmooth leaves; and at the axillas large bright-yellow flowers.

3. The fruticoſa, or ſhrubby, narrow-leaved, perennial tree-primroſe, hath long thick roots; upright, under-ſhrubby like red ſtems, two or three feet high; ſpear-ſhaped, lightly-indented leaves; and at the axillas pedunculated cluſters of yellow flowers, ſucceeded by pedicellated, acute-angled capſules.

4. The pumila, or low perennial tree-primroſe, hath fibrous roots, crowned with many oval, ſpear-ſhaped, cloſe-fitting leaves; ſlender herbaceous ſtems 10 or 12 inches long; garniſhed with ſpear-ſhaped, blunt, ſmooth leaves, having very ſhort foot-ſtalks; and at the axillas ſmalliſh bright-yellow flowers, ſucceeded by acute-angled capſules.

All theſe plants flower very profuſely in June and July, coming out almoſt half the length of the ſtalks from the axillas; and as the ſtalk advances in ſtature, new flowers are produced, ſucceeding thoſe below; in which order the plants continue flowering from about midſummer till October: each flower is moderately large and conſpicuous, conſiſting of four plane petals, which with the calix forms a very long tube below, and ſpreading above, generally expand moſt towards the evening; and are ſucceeded by plenty of ſeed in autumn for propagation.

Theſe plants are exotics from America; but are all very hardy, proſper in any common ſoil and ſituation, and have been long in the Engliſh gardens, eſpecially the three firſt ſorts; but the œnothera biennis is the moſt commonly known.

The firſt and ſecond ſpecies are biennial, and the third and fouth are perennial in root.

They are proper to be employed as plants of ornament for embelliſhing the pleaſure-garden; they may be placed any-where, and will effect a very agreeable variety three or four months with their plentiful blow of flowers.

The biennial kinds muſt be raiſed annually from ſeed, for they totally periſh after they have flowered. But the perennials, once raiſed, continue for years by the root.

The propagation of all the ſorts is by ſeed, and the perennials alſo by parting the roots.

OENOTRIA, an ancient name of Italy; ſo called from the *Oenotri*, (Virgil); inhabiting between Pæſtum and Tarentum, (Ovid). Originally Arcadians, (Dionyſius Halicarnaſſæus), who came under the conduct of Oenotrus ſon of Lycaon, 17 generations before the war of Troy, or 459 years, at 27 years each generation, and gave name to the people. Cato derives the name from *Oenotrus*, king of the Sabines and Etruſcans; but Varro from *Oenotrus*, king of the Latins; and Servius from the Greek name for wine, for which Italy was famous; of which opinion is Strabo.

OENOTRIDES (Strabo, Pliny), two ſmall iſlands in the Tuſcan ſea, over-againſt Velia, a town of Lucania, called *Pontia* and *Iſcia;* now *Penza* and *Iſchta*, on the coaſt of the Principato Citra, or to the weſt of Naples. So called from the *Oenotri*, an ancient people of Italy.

OESEL, an iſland of the Baltic ſea, at the entrance of the gulf of Livonia. It is about 70 miles in length, and 50 in breadth, and contains 10 pariſhes. It is defended by the fortreſſes of Airenſburg and Sonneburg. It is in between 22° and 24° of eaſt longitude, and between 58° and 59° of north latitude.

OESOPHAGUS, in anatomy, the GULA, or *Gullet*, is a membranaceous canal, reaching from the fauces to the ſtomach, and conveying into it the food taken in at the mouth. See ANATOMY, n° 353.

OESTRUS, in zoology, a genus of inſects belonging to the order of diptera. It has no mouth; but three punctures, without trunk or beak: Antennæ taper, proceeding from a lenticular joint. There are five ſpecies.

1. Bovis, the breeze or gad-fly. Thorax yellow, with a black tranſverſe line between the wings: Abdomen tawny, with fine black tranſverſe lines; laſt ſegment black: Wings white, with a brown tranſverſe line, and three brown ſpots. Size of the large blue fly. Depoſits its eggs under the ſkin on the backs of oxen, where the maggots are nouriſhed the whole winter till the month of June; and plague the cattle ſo all the ſummer, that they are obliged to fly for refuge into the water, and dare not quit it the whole day.

2. The hæmorrhoidalis. Body long, black, covered with tawny hair; middle of the thorax leſs hairy; wings immaculate; antennæ very ſhort: Length half an inch. Depoſits its eggs in the rectum of horſes, and occaſions great torment.

3. Ovis, the grey-fly. Spotted with black; front pale yellow; legs browniſh; wings with ſhort black veins: Length half an inch. Breeds in the frontal ſinus of ſheep; where the maggots, hatched from the eggs, lodge the whole winter, vellicating the internal membranes, and often bringing on death.

5. The naſalis. Body black; but the head, thorax, and abomen, covered with pale-red hair, except the firſt ſegment of the latter, which is covered with white hair; the wings immaculate. Breeds in the fauces of horſes, entering by their noſe.

5. The tarandi. Thorax yellow; with a black line between the wings, which are immaculate: abdomen tawny, laſt ſegment black. Infeſt the back of the rein-deer, ſo as greatly to retard the breed. The rein-deer of Lapland are obliged every year to fly to the

the Alpine mountains, to efcape the purfuit of thefe infects: yet a fourth part of their number perifh by them at two years old; the reft are emaciated, and have their fkins fpoiled.

OETA (Strabo, Ptolemy), a mountain of Theffaly, extending from Thermopylæ weftward to the Sinus Ambracius, and in fome meafure cutting at right angles the mountainous country ftretching out between Parnaffus to the fouth, and Pindus to the north. At Thermopylæ it is very rough and high, rifing and ending in fharp and fteep rocks, affording a narrow paffage between it and the fea from Theffaly to Locris, (Strabo): with two paths over it; the one above Trachis, very fteep and high; the other through the country of the Ænianes, much eafier and readier for travellers; by this it was that Leonidas was attacked in rear by the Perfians, (Paufanias). Here Hercules laid himfelf on the funeral pile, (Silius Italicus, Ovid); the fpot thence called *Pyra*, (Livy): who fays, that the extreme mountains to the eaft are called *Oeta;* and hence the poets allege, that day, night, fun, and ftars, arofe from Oeta, (Seneca, Statius, Silius Italicus, Catullus, Virgil's *Culex.)* Circumftances which fhew the height of this mountain.

OETING, a town of Germany, in Upper Bavaria, under the jurifdiction of Burkhaufen. It is divided into the upper and the lower town, and feated on the river Inn, eight miles weft of Burckhaufen. E. Long. 12. 47. N. Lat. 48. 0. There is a great refort of pilgrims to the old chapel.

Oeting, or *Oetingen*, a town of Germany, in the circle of Suabia, and capital of a county of the fame name, feated on the river Wirnitz. E. Long. 10. 45. N. Lat. 48. 52.

Oeting, a county of Germany, in the circle of Suabia, bounded on the north and eaft by Franconia; on the fouth by the duchy of Neuburg; and on the weft by that of Wirtemberg. It is about 40 miles from eaft to weft, and 20 from north to fouth.

OFFA's-dyke, an entrenchment caft up by Offa, a Saxon king, to defend England againft the incurfions of the Welch. It runs through Herefordfhire, Shropfhire, Montgomeryfhire, Denbighfhire, and Flintfhire.

OFFANTO, a river of Italy, in the kingdom of Naples. It rifes in the Appenine mountains, in the Farther Principato; and paffing by Conza, and Monte Verde, it afterwards feparates the Capitanata from the Bafilicata and the Terra-di-Barri, and then it falls into the gulf of Venice, near Salpe.

OFFENCE, in law, an act committed againft the law, or omitted where the law requires it.

OFFICE, a particular charge or truft, or a dignity attended with a public function. See Honour.—The word is primarily ufed in fpeaking of the offices of judicature and policy; as the office of fecretary of ftate, the office of a fheriff, of a juftice of peace, &c.

Office alfo fignifies a place or apartment appointed for officers to attend in, in order to difcharge their refpective duties and employments; as the fecretary's office, ordnance-office, excife-office, fignet-office, paper-office, pipe-office, fix-clerks office, &c.

Office, in architecture, denotes all the apartments appointed for the neceffary occafions of a palace or great houfe; as kitchen, pantries, confectionaries, &c.

Office, in the canon-law, is ufed for a benefice that has no jurifdiction annexed to it.

Duty upon Offices *and Penfions*, a branch of the king's extraordinary perpetual revenue, confifting in a payment of 1 s. in the pound (over and above all other duties) out of all falaries, fees, and perquifites, of offices and penfions payable by the crown. This highly-popular taxation was impofed by ftat. 31 Geo. II. c. 22. and is under the direction of the commiffioners of the land-tax.

OFFICER, a perfon poffeffed of a poft or office. See the preceding article.

The great officers of the crown, or ftate, are, The lord high-fteward, the lord high-chancellor, the lord high-treafurer, the lord-prefident of the council, the lord privy-feal, the lord-chamberlain, the lord high-conftable, and the earl-marfhal; each of which fee under its proper article.

Non-commiffioned Officers, are ferjeant-majors, quarter-mafter ferjeants, ferjeants, corporals, drum and fife majors; who are nominated by their refpective captains, and appointed by the commanding officers of regiments, and by them reduced without a court-martial.

Orderly non-commiffioned Officers, are thofe who are orderly, or on duty for that week; who, on hearing the drum beat for orders, are to repair to the place appointed to receive them, and to take down in writing, in the orderly book, what is dictated by the adjutant, or ferjeant-major: they are then immediately to fhew thefe orders to the officers of the company, and afterwards warn the men for duty.

Flag Officers. See Flag *Officers*, and Admirals.

General Officers, are thofe whofe command is not limited to a fingle company, troop, or regiment; but extends to a body of forces compofed of feveral regiments: fuch are the general, lieutenant-general, major-general, and brigadier.

Officers *of the Houfehold.* See the article Household.

Staff Officers, are fuch as, in the king's prefence, bear a white ftaff, or wand; and at other times, on their going abroad, have it carried before them by a footman bare-headed: fuch are the lord-fteward, lord-chamberlain, lord-treafurer, &c.

The white ftaff is taken for a commiffion; and, at the king's death, each of thefe officers breaks his ftaff over the hearfe made for the king's body, and by this means lays down his commiffion, and difcharges all his inferior officers.

Subaltern Officers are all who adminifter juftice in the name of fubjects; as thofe who act under the earl-marfhal, admiral, &c. In the army, the fubaltern officers are the lieutenants, cornets, enfigns, ferjeants, and corporals.

OFFICIAL, in the canon-law, an ecclefiaftical judge, appointed by a bifhop, chapter, abbot, &c. with charge of the fpiritual jurifdiction of the diocefe.

Official is alfo a deputy appointed by an archdeacon as his affiftant, who fits as judge in the archdeacon's

deacon's court.

OFFICINAL, in pharmacy, an appellation given to ſuch medicines, whether ſimple or compound, as are required to be conſtantly kept in the apothecaries ſhops. The *officinal ſimples* are appointed, among us, by the college of phyſicians; and the manner of making the compoſitions directed in their diſpenſatory. See PHARMACY.

OFFING, or OFFIN, in the ſea-language, that part of the ſea a good diſtance from ſhore, where there is deep water, and no need of a pilot to conduct the ſhip: thus, if a ſhip from ſhore be ſeen ſailing out to ſeaward, they ſay, *ſhe ſtands for the offing;* and if a ſhip, having the ſhore near her, have another a good way without her, or towards the ſea, they ſay, *that ſhip is in the offing*.

OFF-SETS, in gardening, are the young ſhoots that ſpring from the roots of plants; which being carefully ſeparated, and planted in a proper ſoil, ſerve to propagate the ſpecies.

OFF-SETS, in ſurveying, are perpendiculars let fall, and meaſuring from the ſtationary lines to the hedge, fence, or extremity of an incloſure.

OGEE, or O. G. in architecture, a moulding conſiſting of two members, the one concave, and the other convex; or of a round and hollow, like an S. See ARCHITECTURE.

OGILBY (John), an eminent writer, was born in or near Edinburgh, about the 17th of November 1600. His father having ſpent his eſtate, and being priſoner in the King's Bench for debt, could contribute but little to his education; however, he obtained ſome knowledge in the Latin grammar, and afterwards ſo much money as to procure his father's diſcharge from priſon, and to bind himſelf an apprentice to a dancing-maſter in London; when, by his dexterity in his profeſſion, and his complaiſant behaviour to his maſter's ſcholars, he obtained money to buy out the remainder of his time, and to ſet up for himſelf. But being afterwards appointed to dance in the duke of Buckingham's great maſk, he by a falſe ſtep ſtrained a vein in the inſide of his leg, which occaſioned his being ever after ſomewhat lame. When Thomas earl of Strafford was made lord lieutenant of Ireland, he was entertained as a dancing-maſter in his family, and made one of the earl's troop of guards; at which time he compoſed a humorous piece called the *Character of a Trooper*. He was ſoon after appointed maſter of the revels in Ireland, and built a theatre at Dublin. About the time of the concluſion of the war in England, he left Ireland, and, being ſhipwrecked, came to London in a neceſſitous condition; but ſoon after walked to Cambridge, where, being aſſiſted by ſeveral ſcholars, he became ſo complete a maſter of the Latin tongue, that in 1649 he publiſhed a tranſlation of Virgil. He ſoon after learned Greek; and in 1660 publiſhed in folio, a tranſlation of Homer's Iliad, with Annotations. About two years after, he went into Ireland, where he was made maſter of the revels by patent. He then built another theatre in Dublin, which coſt him about 1000 l. He publiſhed at London in folio, a tranſlation of Homer's Odyſſey, with Annotations; and afterwards wrote two heroic poems, intitled the *Epheſian Matron*, and the *Roman Slave*. He next compoſed the Carolics, an epic poem, in 12 books, in honour of king Charles I. but this was entirely loſt in the fire of London; when Mr Ogilby's houſe in White Fryars was burnt down, and his whole fortune, except to the value of five pounds, deſtroyed. He, however, ſoon procured his houſe to be re-built, ſet up a printing-office within it, was appointed his majeſty's coſmographer and geographic printer, and printed ſeveral great works, tranſlated or collected by himſelf and his aſſiſtants, particularly his Atlas. He died in 1676.

OGIVE, in architecture, an arch or branch of a Gothic vault; which, inſtead of being circular, paſſes diagonally from one angle to another, and forms a croſs with the other arches. The middle, where the ogives croſs each other, is called the *key;* being cut in form of a roſe, or a *cul de lampe*. The members or mouldings of the ogives are called *nerves*, *branches*, or *reins;* and the arches which ſeparate the ogives, *double arches*.

OGYGES, king of the Thebans, or, as others, of Ogygia and Actæ, afterwards called *Bœotia* and *Attica*. He is recorded to have been the firſt founder of Thebes and Eleuſin. The famous deluge happened in his time, in which ſome ſay he periſhed with all his ſubjects, 1796 B. C.

OGYGIA, (Homer), the iſland of Calypſo; placed by Pliny in the Sinus Scylaceus, in the Ionian ſea, oppoſite to the promontory Lacinium; by Mela in the ſtrait of Sicily, calling it *Ææe;* which others place at the promontory Circeium, and call it the iſland of *Circe*.

OGYGIA, the ancient name of Thebes in Bœotia; ſo called from Ogyges, an ancient king, under whom happened a great deluge, 1020 years before the firſt olympiad.

OHIO, a river of North America, called by the French the *Beautiful River*, has its ſource between the Allegany mountains and the lake Erie; and running ſouth-weſt through a moſt delightful country, as alſo receiving many ſmaller rivers in its paſſage, at length falls into the Miſſiſippi, in about 37 degrees of latitude. The French had ſeveral forts on and near it; but the whole country through which it flows was ceded by the peace of 1763 to the Britiſh.

O-HETEROA, one of the South Sea iſlands lately diſcovered, is ſituated in W. Long. 150. 47. S. Lat. 22. 27. It is neither fertile nor populous; nor has it an harbour or anchorage fit for ſhipping, and the diſpoſition of the people is hoſtile to ſuch as viſit them.

OIL, in natural hiſtory, an unctuous inflammable ſubſtance, drawn from ſeveral natural bodies, as animal and vegetable ſubſtances.

Animal oils are their fats, which are originally vegetable oils: all animal ſubſtances yield them, together with their volatile ſalts, in diſtillation.

Vegetable oils are obtained by expreſſion, infuſion, and diſtillation.

The oils by expreſſion are obtained from the ſeed, leaves, fruit, and bark of plants; thus, the ſeed of muſtard, and of the ſun-flower, almonds, nuts, beech-maſt, &c. afford a copious oil by expreſſion; and the leaves of roſemary, mint, rue, wormwood, thyme, ſage, &c. the berries of juniper, olives, Indian cloves, nutmeg, mace, &c. the barks of cinnamon, ſaſſafras, and clove, yield a conſiderable proportion of eſſential oil by diſtillation.

Oil. Oil.

The method of procuring oils by expreſſion is very ſimple: thus, if either ſweet or bitter almonds, that are freſh, be pounded in a mortar, the oil may be forced out with a preſs, not heated: and in the ſame manner ſhould the oil be preſſed from linſeed and muſtard. The avoiding the uſe of heat in preparing theſe oils, intended for internal medicinal uſe, is of great importance, as heat gives them a very prejudicial rancidneſs.

This method holds of all thoſe vegetable matters that contain a copious oil, in a looſe manner, or in certain cavities or receptacles; the ſides whereof being broke, or ſqueezed, makes them let go the oil they contain: and thus the zeſt or oil of lemon-peel, orange-peel, citron-peel, &c. may be readily obtained by preſſure, without the uſe of fire. But how far this method of obtaining oils may be applied to advantage, ſeems not hitherto conſidered. It has been commonly applied to olives, almonds, linſeed, rape-ſeed, beech-maſt, ben-nuts, walnuts, bay-berries, mace, nutmeg, &c. but not, that we know of, to juniper-berries, caſhew-nuts, Indian cloves, pine apples, and many other ſubſtances that might be enumerated, both of foreign and domeſtic growth. It has, however, been of late ſucceſsfully applied to muſtard-ſeed, ſo as to extract a curious gold-coloured oil, leaving a cake behind, fit for making the common table-muſtard.

Certain dry matters, as well as moiſt ones, may be made to afford oils by expreſſion, by grinding them into a meal, which being ſuſpended to receive the vapour of boiling water, will thus be moiſtened ſo as to afford an oil in the ſame manner as almonds; and thus an oil may be procured from linſeed, hemp-ſeed, lettuce-ſeed, white-poppy ſeed, &c.

As to the treatment of oils obtained by expreſſion, they ſhould be ſuffered to depurate themſelves by ſtanding in a moderately cool place, to ſeparate from their water, and depoſit their fæces; from both which they ought to be carefully freed. And if they are not thus rendered ſufficiently pure, they may be waſhed well with freſh water, then thoroughly ſeparated from it again by the ſeparating-glaſs, whereby they will be rendered bright and clear.

The next claſs of oils are thoſe made by infuſion, or decoction, wherein the virtues of ſome herb or flower is drawn out in the oil; as the oils of roſes, chamæmile, hypericum, alder, &c. However, theſe require to be differently treated: thus, for the ſcented flowers, particularly roſes, inſolation does beſt; becauſe much boiling would exhale their more fragrant parts: but oils impregnated with green herbs, as thoſe of chamæmile and alder, require long boiling, before they receive the green colour deſired. And, in general, no oils will bear to be boiled any longer than there remains ſome aqueous humidity, without turning black.

There are many compound oils prepared in the ſame manner, *viz.* by boiling and inſolation, and then ſtraining off the oil for uſe.

The ſame contrivance has likewiſe its uſe in making eſſences for the ſervice of the perfumer; not only where eſſential oils cannot be well obtained in ſufficient quantities, but alſo where they are too dear. The eſſential oil of jeſſamine-flowers, honey-ſuckles, ſweet-briar, damaſk-roſes, lilies of the valley, &c. are either extremely dear, or ſcarcely obtainable by diſtillation; and, in ſome of them, the odorous matter is ſo ſubtile, as almoſt to be loſt in the operation. But if theſe flowers be barely infuſed in fine oil of nuts, or oil of ben, drawn without heat, and kept in a cool place, their ſubtile odorous matter will thus paſs into the oil, and richly impregnate it with their flavour. And theſe eſſences may be rendered ſtill more perfect by ſtraining off the oil at firſt put on, and letting it ſtand again, without heat, upon freſh flowers; repeating the operation twice or thrice.

Oils or fats may likewiſe be obtained, by boiling and expreſſion, from certain animal-ſubſtances; for the membranes which contain the fat, being chopped ſmall, and ſet in a pan over the fire, become fit for the canvas bag, and, by preſſure, afford a large quantity of fat; as we ſee in the art of chandlery, which thus extracting the oily matter, leaves a cake behind, commonly called *graves*.

As to the eſſential oils of vegetables, they are obtained by diſtillation with an alembic and a large refrigeratory. Water muſt be added to the materials, in ſufficient quantity to prevent their burning; and they ſhould be macerated or digeſted in that water, a little time before diſtillation. The oil comes over with the water; and either ſwims on the top, or ſinks to the bottom, according as it is ſpecifically heavier or lighter than water.

This proceſs is applicable to the diſtilling of the eſſential oils from flowers, leaves, barks, roots, woods, gums, and balſams, with a ſlight alteration of circumſtances, as by longer digeſtion, briſker diſtillation, &c. according to the tenacity and hardneſs of the ſubject, the ponderoſity of the oil, &c.

Eſſential oils may be divided into two claſſes, according to their different ſpecific gravities; ſome floating upon water, and others readily ſinking to the bottom. Thus, the eſſential oils of cloves, cinnamon, and ſaſſafras, readily ſink; whereas thoſe of lavender, marjoram, mint, &c. ſwim in water: the lighteſt of theſe eſſential oils is, perhaps, that of citron-peel, which even floats in ſpirit of wine; and the heavieſt ſeems to be oil of ſaſſafras.

For obtaining the full quantity of the more ponderous oils from cinnamon, cloves, ſaſſafras, &c. it is proper to reduce the ſubjects to powder; to digeſt this powder for ſome days in a warm place, with thrice its quantity of ſoft river-water, made very ſaline by the addition of ſea-ſalt, or ſharp with oil of vitriol; to uſe the ſtrained decoction, or liquor left behind in the ſtill, inſtead of common water, for freſh digeſtion; to uſe for the ſame purpoſe the water of the ſecond running, after being cleared of its oil; not to diſtil too large a quantity of theſe ſubjects at once; to leave a conſiderable part of the ſtill, or about one fourth, empty; to uſe a briſk fire, or a ſtrong boiling heat, at the firſt, but to ſlacken it afterwards; to have a low ſtill-head, with a proper internal ledge and current leading to the noſe of the worm; and, finally, to cohobate the water, or pour back the liquor of the ſecond running upon the matter in the ſtill, repeating this once or twice.

The directions here laid down for obtaining the ponderous oils to advantage, are eaſily transferred to the obtaining of the lighter; ſo that we need not dwell particularly upon them.

Many of the eſſential oils being dear, it is a very common practice to adulterate or debaſe them ſeveral ways, ſo as to render them cheaper both to the ſeller and the buyer. Theſe ſeveral ways ſeem reducible to three general kinds, each of which has its proper method of detection, viz. 1. With expreſſed oils. 2. With alcohol. And, 3. With cheaper eſſential oils.

If an eſſential oil be adulterated with an expreſſed oil, it is eaſy to diſcover the fraud; by adding a little ſpirit of wine to a few drops of the ſuſpected eſſential oil, and ſhaking them together; for the ſpirit will diſſolve all the oil that is eſſential, or procured by diſtillation, and leave all rhe expreſſed oil that was mixed with it, untouched.

If an eſſential oil be adulterated with alcohol, or rectified ſpirit of wine, it may be done in any proportion, up to that of an equal quantity, without being eaſily diſcoverable either by the ſmell or taſte: the way to diſcover this fraud, is to drop a few drops of the oil into a glaſs of fair water; and if the oil be adultered with ſpirit, the water will immediately turn milky, and, by continuing to ſhake the glaſs, the whole quantity of ſpirit will be abſorbed by the water, and leave the oil pure at top.

Finally, if an eſſential oil be adulterated by a cheaper eſſential oil, this is commonly done very artfully: the method is to put fir-wood, turpentine, or oil of turpentine, into the ſtill, along with the herbs to be diſtilled for their oil, ſuch as roſemary, lavender, origanum, &c. and by this means, the oil of turpentine diſtilled from theſe ingredients, comes over in great quantity, and intimately blended with the oil of the genuine ingredient. The oils thus adulterated always diſcover themſelves in time, by their own flavour being overpowered by the turpentine-ſmell: but the ready way to detect the fraud, is to drench a piece of rag, or paper, in the oil, and hold it before the fire; for thus the grateful flavour of the plant will fly off, and leave the naked turpentine-ſcent behind.

The virtues of oils being the ſame with thoſe of the ſubſtances from whence they are obtained, may be learned under their ſeveral articles.

Method of Purifying Rancid OILS. See CHEMISTRY, n° 497.

OINTMENT, in pharmacy. See UNGUENT.

OKEHAM, the capital of Rutlandſhire, in England, ſeated in a rich and pleaſant valley, called the *vale of Catmus*. It is pretty well built, has a good church, a free-ſchool, and an hoſpital. W. Long. 0. 45. N. Lat. 52. 40.

OKINGHAM, OCKINGHAM, or *Woxingham*, a large town of Berkſhire, in England, noted for the manufacture of ſilk ſtockings. W. Long. 0. 50. N. Lat. 51. 26.

OLAUS MAGNUS, archbiſhop of Upſal in Sweden, ſucceeded his brother John Magnus in 1544. He appeared with great credit at the council of Trent in 1546, and ſuffered much afterward for the Catholic religion. We have of his writing, A Hiſtory of the Manners, Cuſtoms, and Wars of the Northern Nations of Europe.

OLD-AGE. See LONGEVITY.

OLD-*Man of the Mountain*. See ASSASINS.

OLDCASTLE (Sir John), called the *Good Lord Cobham*, was born in the reign of Edward III. and was the firſt author as well as the firſt martyr among the Engliſh nobility: he obtained his peerage by marrying the heireſs of that Lord Cobham who with ſo much virtue and patriotiſm oppoſed the tyranny of Richard II. By his means the famous ſtatute againſt proviſors was revived, and guarded againſt by ſeverer penalties; he was one of the leaders of the reforming party; was at great expence in procuring and diſperſing copies of Wickliffe's writings among the people, as well as by maintaining a number of his diſciples as itinerant preachers. In the reign of Henry V. he was accuſed of hereſy; the growth of which was attributed to his influence. Being a domeſtic in the king's court, the king delayed his proſecution that he might reaſon with him himſelf; but not being able to reclaim him to the church of Rome, he in great diſpleaſure reſigned him to its cenſure He was apprehended and condemned for hereſy; but eſcaping from the tower, lay concealed for four years in Wales, until the rumour of a pretended conſpiracy was raiſed againſt him, and a price ſet upon his head: he was at laſt ſeized, and executed in St Giles's Fields; being hung alive in chains upon a gallows, and burned by a fire placed underneath. He wrote "Twelve Concluſions, addreſſed to the Parliament of England."

OLDENBURG (Henry), a learned German gentleman in the 17th century, was deſcended from the noble family of his name, who were earls of the county of Oldenburg, in the north part of Weſtphalia for many generations. He was born in the duchy of Bremen in the Lower Saxony; and during the long Engliſh parliament in king Charles I's. time, was appointed conſul for his countrymen, at London, after the uſupation of Cromwell: but being diſcharged of that employ, he was made tutor to the lord Henry O'Bryan, an Iriſh nobleman, whom he attended to the univerſity of Oxford, where he was admitted to ſtudy in the Bodleian library in the beginning of the year 1656, when Cromwell was vice-chancellor. He was afterwards tutor to William lord Cavendiſh, and was acquainted with Milton the poet. During his reſidence at Oxford, he became alſo acquainted with the members of that ſociety there, which gave birth to the royal ſociety; and upon the foundation of this latter, he was elected fellow; and when the ſociety found it neceſſary to have two ſecretaries, he was choſen aſſiſtant-ſecretary to Dr Wilkins. He applied himſelf with extraordinary diligence to the buſineſs of his office, and began the publication of the Philoſophical Tranſactions with N° 1. in 1664. In order to diſcharge this taſk with greater credit to himſelf and the ſociety, he held a correſpondence with more than ſeventy learned perſons, and others, upon a vaſt variety of ſubjects, in different parts of the world. This fatigue would have been inſupportable, had not he, as he told Dr Liſter, managed it ſo as to make one letter anſwer another, and that, to be always freſh, he never read a letter before he had pen, ink and paper, ready to anſwer it forthwith; ſo that the multitude of his letters cloyed him not, nor ever lay upon his hands. Among others, he was a conſtant correſpondent of Mr Robert Boyle, with whom he had a very intimate friendſhip; and he tranſlated ſeveral of that ingenious gentleman's works into Latin.

Mr Oldenburg continued to publifh the Tranfactions, as before, to N° xxxvi. June 25, 1677. After which the publication was difcontinued till the January following, when it was again refumed by his fucceffor in the fecretary's office, Mr Nehemiah Grew, who carried it on till the end of February 1678. Our author dying at his houfe at Charleton, near Greenwich in Kent, in the month of Auguft that year, was interred there.

OLDHAM (John), an eminent Englifh poet in the 17th century, fon of a non-conformift minifter, was educated under his father, and then fent to Edmund-hall in Oxford. He became ufher to the free-fchool at Croyden in Surry; where he received a vifit from the earls of Rochefter and Dorfet, Sir Charles Sedley, and other perfons of diftinction, merely upon the reputation of fome verfes which they had feen in manufcript. He was tutor to feveral gentlemens fons fucceffively; and having faved a fmall fum of money, came to London, and became a perfect votary to the bottle, being an agreeable companion. He was quickly found out here by the noblemen who had vifited him at Croydon, who brought him acquainted with Mr Dryden. He lived moftly with the earl of Kingfton at Holme-Pierpoint in Nottinghamfhire, where he died of the fmall-pox in 1683, in the 30th year of his age. His acquaintance with learned authors appears by his fatires againft the Jefuits, in which there is as much learning as wit difcovered. Mr Dryden efteemed him highly. His works are printed in 2 vols 12mo. They chiefly confift of fatires, odes, tranflations, paraphrafes of Horace and other authors, elegiac verfes, imitations, parodies, familiar epiftles, &c.

OLDMIXON (John) was defcended from an ancient family in Somerfetfhire: he was a violent party-writer and malevolent critc, who would fcarcely have been remembered, if Pope, in refentment of his abufe, had not condemned him to immortality in his Dunciad. His party-writings procured him a place in the revenue at Liverpool, where he died at an advanced age in the year 1745. Befides his fugitive temporary pieces, he wrote a hiftory of the Stuarts in folio; a critical hiftory of England, 2 vols 8vo; a volume of poems, fome dramatic pieces, &c.; none of them worthy of notice, his principal talent being that of falfifying hiftory.

OLD-WIFE, or *Wraffe*, See LABRUS.

OLD-WIFE *Fifh*. See BALISTES.

OLEA, the OLIVE-TREE; a genus of the monogynia order, belonging to the diandria clafs of plants.

There are two fpecies, 1. The Europea, or common olive-tree, rifes with upright folid ftems, branching numeroufly on every fide, 20 or 30 feet high; fpear-fhaped, ftiff, oppofite leaves, two or three inches long, and half an inch or more broad; and at the axillas fmall clufters of white flowers, fucceeded by oval fruit.

This fpecies is the principal fort cultivated for its fruit; the varieties of which are numerous, varying in fize, colour, and quality.

It is a native of the fouthern warm parts of Europe, and is cultivated in great quantities in the fouth of France, Italy, and Portugal, for the fruit to make the olive-oil, which is in fo great repute, and is tranfported to all parts. to the great advantage of thofe countries where the trees grow in the open ground: the green fruit is alfo in much efteem for pickling, of which we may fee plenty in the fhops.

2. The capenfis, or cape box-leaved olive, rifes with fhrubby ftems, branching numeroufly from the bottom, fix or feven feet high; fmall, oval, thick, ftiff, fhining leaves; and at the axillas fmall clufters of whitifh flowers; fucceeded by fmall fruit of inferior value.

Thefe plants in this country muft be kept principally in pots for moving to fhelter of a green-houfe in winter; for they are too render to profper well in the open ground here: though fometimes they are planted againft a warm fouth wall, and fheltered occafionally from froft in winter, by mulching the roots, and matting their tops; whereby they may be preferved, and will fometimes produce fruit for pickling: a very fevere winter, however, often kills or greatly injures their young branches; therefore let the principal part be potted in rich earth, and placed among the green-houfe fhrubs, and managed as others of that kind.

Thefe trees are often fent over from Italy to the Italian warehoufes in London, along with orange-trees, &c. where pretty large plants may be purchafed reafonably, which fhould be managed as directed for orange-trees that are imported from the fame country. See CITRUS.

Their propagation here is commonly by layers.

The laying is performed on the young branches in fpring. Give plenty of water all fummer, and they will fometimes be rooted fit for potting-off by autumn; but fometimes they require two fummers to be rooted effectually: when, however, they are properly rooted take them off early in autumn, and pot them feparately, give water, and place them in the fhade till they have taken frefh root; and in October remove them into the green-houfe, &c.

Thofe you intend to plant in the open ground, as before fuggefted, fhould be kept in pots; in order to have occafional fhelter of a garden-frame two or three years, till they have acquired fome fize, and are hardened to the full air; then tranfplant them into a warm border againft a wall: mulch their roots in winter, and mat their tops in frofty weather.

Olives have an acrid, bitter, extremely difagreeable tafte: pickled (as we receive them from abroad) they prove lefs difagreeable. The Lucca olives, which are fmaller than the others, have the weakeft tafte; the Spanifh, or larger, the ftrongeft; the Provence, which are of a middling fize, are generally the moft efteemed.

The oil obtained from this fruit has no particular tafte or fmell, and does not greatly differ in quality from oil of almonds. Authors make mention of two forts of this oil, one expreffed from the olives when fully ripe, which is our common oil olive; the other, before it has grown ripe; this is called *oleum immaturum*, and *omphacinum*. Nothing is met with in the fhops under this name; and Lemery affirms, that there is no fuch oil, unripe olives yielding only a vifcid juice to the prefs. From the ripe fruit, two or three forts are obtained, differing in degree of purity: the pureft runs by light preffure; the remaining magma, heated and preffed

fed more strongly, yields an inferior sort, with some dregs at the bottom, called *amurca*. All these oils contain a considerable quantity of aqueous moisture, and a mucilaginous substance, which subject them to run into a putrid state: to prevent this, the preparers add some sea-salt, which, imbibing the aqueous and mucilaginous parts, sinks with them to the bottom; by this means the oil becomes more homogene, and consequently less susceptible of alteration. In its passage to us, some of the salt, thrown up from the bottom by the shaking of the vessel, is sometimes mixed with and detained in the oil, which, in our colder climate, becomes too thick to suffer it freely to subside; and hence the oil is sometimes met with of a manifestly saline taste. Oil- olive is used in the simple balsam of sulphur, Locatelli's balsam, and several ointments. It is oftener employed in this last intention than the other expressed oils, but more rarely for internal medicinal purposes.

OLEAGINOUS, something that partakes of the nature of oil, or out of which oil may be expressed.

OLECRANUM, or OLECRANON, in anatomy, the protuberance of the ulna, which prevents the joint of the elbow from being bent back beyond a certain length. See ANATOMY, n° 50.

OLEARIUS (Adam), minister to the duke of Holstein, and secretary to the embassy sent in 1633 to the great duke of Muscovy and to the king of Persia. He spent six years in this employment; and, on his return, published a relation of his journeys, with maps and figures, at Sleswic 1656, in folio. He wrote an *Abridgement of the chronicles of Holstein from* 1448 *to* 1663: and was appointed librarian to the duke of Holstein, in which capacity he probably died. He has the character of an able mathematician, an adept of music, and a good orientalist, especially in the Persian language.

OLEARIUS (Godfrey), son of Godfrey Olearius, D. D. superintendant of Halle in Saxony, was born there in 1639. He became professor of Greek at Leipsic; and shewed his abilities in that language by 52 exercitations on the dominical epistles, and upon those parts of the epistles in the New Testament which are read in the public exercises, and which among the Lutherans are the subject of part of their sermons. He discharged the most important posts in the university, and among other dignities was ten times rector of it. His learning and industry were displayed in 106 theological disputations, 61 in philosophy, some programmas upon difficult points, several speeches and theological counsels; which make two thick volumes: beside his *Moral Theology*, his *Introduction to Theology*, which treats of cases of conscience, and his *Hermeneutica Sacra*. He lived to a good old age, dying in 1713. His eldest son of his own name, was a man of genius and learning, a professor in the same university, who published several works, but died young of a consumption before his father.

OLERON, an island of France, on the coast of Aunis and Saintonge, about five miles from the continent. It is 12 miles in length, and five in breadth; and is very fertile, containing about 12,000 inhabitants, who are excellent seamen. It is defended by a castle, which is well fortified; and there is a lighthouse placed here for the direction of ships. It is 14 miles south-east of Rochelle. W. Long. 1. 26. N. Lat. 46. 10.

Sea-Laws of OLERON, certain laws relative to maritime affairs, made in the time of Richard I. when he was at the island of Oleron. These laws, being accounted the most excellent sea-laws in the world, are recorded in the black book of the admiralty. See *Selden's Mare Clausum.*

OLFACTORY-NERVES. See ANATOMY, n°400.

OLIBANUM, (FRANKINCENSE), in pharmacy, a dry resinous substance, brought to us in detached pieces, or drops, as it were, like those of mastic; but larger, and of a less pure and pellucid texture. This drug has received many different appellations, according to its different appearances: the single tears are called simply *olibanum*, or *thus;* when two are joined together, they have been called *thus masculum*, and when very large, *thus fœmininum:* sometimes four or five, about the bigness of filberds, are found adhering to a piece of the bark of the tree which they exsuded from; these have been named *thus corticosum:* the finer powder which rubs off from the tears in the carriage, *mica thuris;* and the coarser powder, *manna thuris*. This drug is not however in any of its states which is now called *thus* or *frankincense* in the shops. See the article THUS.

Olibanum consists of about equal parts of a gummy and resinous substance; the first soluble in water, the other in rectified spirit. With regard to its virtues, abundance have been attributed to it, particularly in disorders of the head and breast, in hæmoptoes, and in alvine and uterine fluxes: but its real effects in these cases are far from answering the promises of the recommenders. Riverius is said to have had large experience of the good effects of this drug in pleurisies, especially epidemic ones: he directs a scooped apple to be filled with a dram of olibanum, then covered and roasted under the ashes; this is to be taken for a dose, three ounces of carduus water after it, and the patient covered up warm in bed; in a short time, he says, either a plentiful sweat, or a gentle diarrhœa, ensues, which carry off the disease. Geoffroy informs us, that he has frequently made use of this medicine after venesection, with good success; but acknowledges that it has sometimes failed.

OLIGÆDRA, in natural history, the name of a genus of crystals composed of very few planes, as the name expresses. The bodies of this class are crystals of the imperfect kind; being composed of columns affixed irregularly to some solid body at one end, and the other terminated by a pyramid: but the column and pyramid being both pentangular, the whole consists only of ten planes, and not, as the common kind, of 12.

OLIGARCHY, a form of government, wherein the administration of affairs is confined to a few hands.

OLISIPO, (Pliny, Antonine, Inscriptions); a town of Lusitania, situate on the north side of the frith of the Tagus; of such antiquity, that Solinus thought it was built by Ulysses: and Mela, probably to favour this opinion, writes, according the common copies, *Ulyssipo;* both of them perhaps deceived by the similarity of sound. It was a municipium, with the surname *Felicitas Julia*, a privilege granted by the munificence

nificence of Auguftus, (Infcriptions, Pliny.) Now *Lifbon*, capital of Portugal, fituate on the north bank of the Tagus, diftant about ten miles from its mouth.

OLIO, in cookery, denotes a favoury difh compofed of a great variety of ingredients, chiefly ufed by the Spaniards.

OLIVE, in botany. See OLEA.

Plate CCI. fig. 3.

OLIVE-*Prefs*. In order to obtain the olive oil, the olives are firft bruifed in a rough trough, under a millftone, rolling perpendicularly over them; and when fufficiently mafhed, put into the maye, or trough, *m*, of an olive-prefs, where *aa* are the upright beams, or cheeks; *b*, the female, and *c*, the male fcrew; *f*, the board on which the fcrew preffes; *g*, a cubical piece of wood, called a *block*; *b*, the peel, a circular board, to be put under the block. By turning the fcrew, all the liquor is preffed out of the mafhed olives, and is called *virgin-oil*; after which, hot water being poured upon the remainder in the prefs, a coarfer oil is obtained. Olive-oil keeps only about a year, after which it degenerates.

OLIVE-*Colour*, a yellow mingled with black.

OLIVER (Ifaac), an excellent Englifh painter, born in 1556; eminent both for hiftory and portraits. Several fine miniatures of this mafter are to be feen in the collections of our nobility and gentry; fome of them portraits of himfelf. As he was a very good defigner, his drawings are finifhed to an extraordinary degree of perfection; many being copies after Parmegiano. Rubens and Vandyck painted James I. after a miniature of Oliver's, which is a fufficient teftimony of his merit. He died in 1617.

OLIVER (Peter), the fon and difciple of Ifaac Oliver, was born in 1601. He arrived at a degree of perfection in miniature portraits confeffedly fuperior to his father, or any of his cotemporaries; as he did not confine his fubjects to a head only. In the collections of Charles I. and James II. there were 13 hiftorical fubjects painted by this Oliver; of which feven are ftill preferved in the clofet of queen Caroline at Kenfington: and a capital painting of his wife is in the poffeffion of the duchefs of Portland. He died in 1660.

OLIVET, or *Mount of* OLIVES, (anc. geog.), a mount which lay a little without Jerufalem, on the eaft fide (Zechar. xiv.); feparated from it by a deep valley called *Kedron*, (Jofephus), or the valley of Jehofaphat; diftant about eight furlongs or a mile from Jerufalem, (Luke); five furlongs, (Jofephus); which may be underftood of the nearer part of the mount.

OLMUTZ, a town of Germany, in Moravia, with a bifhop's fee, and a famous univerfity. The public buildings are very handfome, particularly the Jefuits college. It is a populous, trading, and very ftrong place; and yet it was taken, with the whole garrifon, by the king of Pruffia in 1741. In July 1758, he befieged it again; and when he had almoft taken the place, he was obliged to raife the fiege, to go and meet the Ruffian army. It is feated on the river Morave. E. Long. 17. 35. N. Lat. 49. 30.

OLYMPIA, (anc. geog.), with the furname *Pifatis*, (Strabo); fo called from the territory of Pifa in Elis; defcribed by Strabo, "as the temple of Jupiter Olympius, before which ftands a grove of wild olivetrees, in which is the ftadium, or foot-courfe, fo called, becaufe the eighth part of a mile; and by which the Alpheus, coming down from Arcadia, runs." A temple and fhrine highly ennobled by gymnaftic exercifes; and diftinguifhed by a peculiar degree of veneration, and ftill more fo by the ftatue of Jupiter, the work of Phidias, (Mela): fituated between Offa and Olympius, mountains cognominal with thofe of Theffally, diftant 12 miles from Pylos; famous for games called the *Olympian*, celebrated the beginning of each fifth year, by which Greece computed time, (Pliny;) a period of four years complete being called an *Olympiad*. Olympia was anciently called *Pifa*, or Pifa ftood in its neighbourhood; and there Jupiter Olympius was worfhipped. Hiftorians take no notice of Pifa, though poets do, but only of Olympia: which is thought to have arifen, if it had ever any habitations, (fo as to become a town or village, befides the temple and place of exercife,) from the ruins of Pifa; deftroyed by the Eleans, according to Paufanias; who adds, that not a veftige either of the houfes or walls was to be feen, but a plantation of vines on the fpot where it ftood. Again, Olympia and Pifa are faid to have ftood on different fpots, but in each other's adjacency. The public edifices of Olympia were the temple of Jupiter, the gymnafium, the portico, the dwellings of the Athletæ, the ftadium or raifed caufeway, the Hippodromus or chariot-courfe, the barrier and goal. *Olympiacus*, (Virgil;) *Olympicus*, (Horace;) the epithets. Now called *Longinico*, in the Morea: E. Long. 22. 0. N. Lat. 37. 30.

OLYMPIAD, the fpace of four years, whereby the Greeks reckoned time.

OLYMPIC GAMES, were folemn games among the ancient Greeks, fo called from Olympian Jupiter, to whom they were dedicated; and by fome faid to be firft inftituted by Jupiter, after his victory over the fons of Titan; others afcribe their inftitution to Hercules, not the fon of Alcmena, but one of much greater antiquity; others to Pelops; and others to Hercules the fon of Alcmena. Thefe games were fo confiderable, that the Greeks made them their epocha, diftinguifhing their years by the return of the Olympic games.

The care and management of the Olympics belonged for the moft part to the Eleans; who, on that account, enjoyed their poffeffions without moleftation or fear of war or violence. They appointed a certain number of judges, who were to take care that thofe who offered themfelves as competitors fhould perform their preparatory exercifes; and thefe judges, during the folemnity, fat naked, having before them a crown of victory, formed of wild olive, which was prefented to whomfoever they adjudged it. Thofe who were conquerors were called *Olympionices*, and were loaded with honours by their countrymen. At thefe games women were not allowed to be prefent; and if any woman was found, during the folemnity, to have paffed the river Alpheus, fhe was to be thrown headlong from a rock.

OLYMPUS, the name of feveral mountains; one bounding Bithynia on the fouth. Another in the ifland of Cyprus, on whofe top was a temple of Venus, which women were not permitted either to enter or to fee, (Strabo.) A third Olympus of Galatia, (Livy.) A fourth, of Lycia, with a noble cognominal town, near

near the fea-coaft, (Strabo, Cicero); extinct in Pliny's time, there remaining only a citadel: the town was deftroyed by P. Servilius Ifauricus, (Florus); having been the retreat of pirates. From this mountain there was an extenfive profpect of Lycia, Pamphylia, and Pifidia, (Strabo.) A fifth Olympus of Myfia, (Ptolemy); thence furnamed *Olympena*, anciently *Minor;* one of the higheft mountains, and furnamed *Myfius*, (Theophraftus); fituate on the Propontis, and thence extending more inland. A fixth, on the north of Theffaly, or on the confines of Macedonia; famous for the fable of the giants, (Virgil, Horace, Seneca); reckoned the higheft in the whole world, and to exceed the flight of birds, (Apuleius); which is the reafon of its being called *heaven*, than which nothing is higher: the ferenity and calmnefs which reign there are celebrated by Homer, Lucan, and Claudian.

OMBRE, a celebrated game at cards, borrowed from the Spaniards, and played by two, by three, or by five perfons, but generally by three. When three play at this game, nine cards are dealt to each party; the whole ombre pack being only 40; becaufe the eights, nines, and tens are thrown out of the pack. There are two forts of counters for ftakes, the greater and the leffer; the laft having the fame proportion to the other, as a penny to a fhilling: of the greater counters each man ftakes one for the game; and one of the leffer for paffing, for the hand when eldeft, and for every card taken in. As to the order and value of the cards, the ace of fpades, called *fpadillo*, is always the higheft trump, in whatfoever fuit the trump be; the *manille*, or black-duce, is the fecond; and the *bafto*, or ace of clubs, is always the third: the next in order is the king, the queen, the knave, the feven, the fix, the five, four, and three. Of the black there are 11 trumps; of the red, 12. The leaft fmall cards of the red are always the beft, and the moft of the black; except the duce and red feven, both of which are called the *manilles*, and are always fecond when the red is a trump. The red ace, when a trump, enters into the fourth place, and is called *punto*, otherwife it is only called an *ace*. The three principal cards are called *matadores;* which have this privilege, that they are not obliged to attend an inferior trump when it leads; but for want of a fmall trump, the perfon may renounce trumps, and play any other card; and when thefe are all in the fame hand, the others pay three of the greater counters a-piece; and with thefe three for a foundation, he may count as many matadores as he has cards in an uninterrupted feries of trumps; for all which the others are to pay one counter a-piece. He who hath the firft hand is called *ombre*, and has his choice of playing the game, of naming the trump, and of taking in as many and as few cards as he pleafes; and after him the fecond, &c. But if he does not name the trump before he look on the cards he has taken in, any other may prevent him, by naming what trump he pleafes. He that has the firft hand, fhould neither take in, nor play, unlefs he has at leaft three fure tricks in his hand: for, as he wins the game who wins moft tricks, he that can win five of the nine has a fure game; which is alfo the cafe if he wins four, and can fo divide the tricks as that one perfon may win two, and the other three.

If a perfon plays without difcarding or changing any cards, this is called *playing fans prendre;* and if another wins more tricks than he, he is faid to win codille. The over-fights in the courfe of the game, are called *beafts*. And if the ombre wins all the nine tricks, it is called *winning the vole*.

In ombre by five, which many, on account of its not requiring fo clofe an attention, prefer to that by three, only eight cards a-piece are dealt; and five tricks muft be won, otherwife the ombre is beafted. Here, the perfon who undertakes the game, after naming the trump, calls a king to his affiftance; upon which the perfon in whofe hand the king is, without difcovering himfelf, is to affift him as a partner, and to fhare his fate. If, between both, they can make five tricks, the ombre wins two counters, and the auxiliary king only one; but when the counters are even, they divide them equally. If the ombre venture the game without calling in any king, this too is called *playing fans prendre;* in which cafe other four are all againft him, and he muft win five tricks alone, or be beafted. The reft is much the fame as by three.

Ombre *de foleil*, "Shadow of the fun," in heraldry, is when the fun is borne in armory, fo as that the eyes, nofe, and mouth, which at other times are reprefented, do not appear; and the colouring is thin, fo that the field can appear through it.

OMBRIA, the ancient name of a province of Italy, in the territory of the pope, now called *Spoletto* and *Perugia*.

OMBRO, or Lombro, a town of Italy, in the duchy of Tufcany, and territory of the Siennois, fituated near the Tufcan fea, a little fouth of the lake of Caftiglione, 45 miles fouth-weft of Sienna.

OMELET, or Amlet, a kind of pancake or fricaffee of eggs, with other ingredients, very ufual in Spain and France. It may be made as follows: the eggs being beaten, are to be feafoned with falt and pepper, and then fried in butter made boiling hot; this done, gravy is to be poured on, and the whole ftewed with chives and parfley fhred fmall: when one fide is fried enough, it is to be turned on the other.

OMEN, a certain accident and cafual occurrence, that was thought to prefage either good or evil. There were three forts of omens among the ancients: one was of things internal, or thofe which affected the perfons themfelves; the fecond, of things external, that only appeared to men, but did not make any impreffion on them; the third were ominous words. Of the firft fort were thofe fudden conflernations, called *panic fears*, that feized upon men without any vifible caufe, and were therefore imputed to the demons, efpecially the god Pan: of thefe panics there is frequent mention in hiftory. The fecond fort of omens were of fuch things as appeared to men, but were not contained in their own bodies: of thefe there were feveral forts; the beginning of things were thought to contain fomething ominous; it was thought a direful omen, when any thing unufual befel the temples, altars, or ftatues of the gods: under the head of external omens are to be placed thofe which offered themfelves in the way; fuch were the meeting of an eunuch, a black, a bitch with whelps, a fnake lying in the road, &c. Words were ominous, and, as they were good or bad, were believed to prefage accordingly

ingly.

OMENTUM, or Epiloon, the *Cawl*, in anatomy, a membranaceous part, usually furnished with a large quantity of fat; being placed under the peritonæum, and immediately above the intestines. See Anatomy, n° 351.

OMBROMETER, a machine to measure the quantity of rain that falls. We have the description and sign of one in Phil. Transf. n° 473. p. 12. It consists of a tin funnel, whose surface is an inch square, with a flat board, and a glass tube set into the middle of it in a groove. The rise of the water in the tube, whose capacity at different times must be measured and marked, shews the quentity of rain that has fallen.

OMOPHAGIA, an ancient Greek festival, in honour of Bacchus, firnamed *Omophagos*, *i. e.* eater of raw-flesh. This festival was observed in the same manner with the other festivals of Bacchus, in which they counterfeited madness; what was peculiar to it, was, that the worshippers used to eat the entrails of goats, raw and bloody, in imitation of the god, who was supposed to do the same thing.

OMPHALMO-mesenteric, in anatomy. All fœtuses are wrapped up in at least two coats or membranes; most of them have a third, called *allantoides*, or *urinary*.

Some, as the dog, cat, hare, &c. have a fourth, which has two blood-vessels, viz. a vein and an artery, called *omphalo-mesenterics*, because passing along the string to the navel, and terminating in the mesentery.

ON, (anc. geog.), a town of Egypt towards Arabia, to the south-east of Babylon, and of the eastern branch of the Nile. The prophet Jeremiah calls it the house or town of the sun, in the land of Egypt. The high-priest Onias built a temple here, held in great esteem by the Hellenists.

ONANIA, or Onanism, terms lately framed to denote the crime of self-pollution, mentioned in scripture to have been committed by Onan, and punished in him with death.

This practice, however common, hath among all nations been reckoned a very great crime. In scripture, besides the instance of Onan abovementioned, we find self-polluters termed *effeminate*, *unclean*, *filthy*, and *abominable*. Even the heathens, who had not the advantage of revelation, were of the same opinion, as appears from the following lines of Martial.

Hoc nihil esse putes! scelus est; mihi crede, sed ingens
Quantum vix animo concipis ipse tuo.

You think 'tis nothing! 'tis a crime, believe!
A crime so great you scarcely can conceive.

Dr Tissot has published a treatise on the pernicious effects of this shameful practice, which appears to be no less baneful to the mind than to the body. He begins with observing, that, by the continual waste of the human body, aliments are required for our support. These aliments, however, require certain preparations in the body itself; and when by any means we become so altered that these preparations cannot be effected, the best aliments then prove insufficient for the support of the body. Of all the causes by which this morbid alteration is brought on, none is more common than too copious evacuations; and of all evacuations, that of the semen is the most pernicious when carried to excess. It is also to be observed, that though excess in natural venery is productive of very dangerous disorders, yet an equal evacuation by self-pollution, which is an unnatural way, is productive of others still more to be dreaded. The consequences enumerated by Dr Tissot are as follow.

1. All the intellectual faculties are weakened; the memory fails; the ideas are confused, and the patient sometimes even falls into a slight degree of insanity. They are continually under a kind of inward restlessness, and feel a constant anguish. They are subject to giddiness; all the senses, especially those of seeing and hearing, grow weaker and weaker, and they are subject to frightful dreams.

2. The strength entirely fails, and the growth in young persons is considerably checked. Some are afflicted with almost continual watching, and others dose almost perpetually. Almost all of them become hypochondriacs or hysteric, and are afflicted with all the evils which attend these disorders. Some have been known to spit calcareous matter; and others are afflicted with coughs, slow fevers, and consumptions.

3. The patients are affected with the most acute pains in different parts of the body, as the head, breast, stomach, and intestines; while some complain of an obtuse sensation of pain all over the body, on the slightest impression.

4. There are not only to be seen pimples on the face, which are one of the most common symptoms; but even blotches, or suppurative pustules, appear on the face, nose, breast, and thighs; and sometimes fleshy excrescences arise on the forehead.

5. The organs of generation are also affected; and the semen is evacuated on the slightest irritation, even that of going to stool. Numbers are afflicted with an habitual gonorrhœa, which entirely destroys the vigour of the constitution, and the matter of it resembles a fetid sanies. Others are affected with painful priapisms, dysuries, stranguries, and heat of urine, with painful tumours in the testicles, penis, bladder, and spermatic cord.

6. The functions of the intestines are sometimes totally destroyed; and some patients complain of costiveness, others of diarrhœa, piles, and the running of a fœtid matter from the fundament.

With regard to the cure, the first step is to leave off those practices which have occasioned the disease: which our author asserts is no easy matter; as, according to him, the soul itself becomes polluted, and can dwell on no other idea; or if she does, the irritability of the parts of generation themselves quickly recal ideas of the same kind. This irritability is no doubt much more to be dreaded than any pollution the soul can have received; and by removing it, there will be no occasion for exhortations to discontinue the practice. The principal means for diminishing this irritability are, in the first place, to avoid all stimulating, acrid, and spiced meats. A low diet, however, is improper, because it would further reduce the body already too much emaciated. The food should therefore be nutritive, but plain, and should consist of flesh rather roasted than boiled, rich broths, &c. It is certain,

tain, however, that as these foods contribute to restore the strength of the body, the stimulus on the organs of generation will be proportionably increased, by the semen which is constantly secreted, and which will now be in larger quantity than even in healthy persons, owing to the great evacuations of it which have preceded. Some part of the semen is gradually absorbed by the lymphatics; in consequence of which, the remainder becomes thick, acrid, and very stimulating. To remedy this, exercise is to be used, and that not only for pleasure, but till it is attended with a very considerable degree of fatigue. The sleep also must be no more than is barely sufficient to repair the fatigues occasioned by the exercise, or other employment; for an excess in sleep is as bad as idleness or stimulating foods. Excess in wine or intoxicating liquors is also to be avoided; or rather such liquors ought never to be tasted, unless as a medicine to restore the exhausted spirits: and to all this ought to be joined the Peruvian bark, which hath this admirable property, that, with little or no stimulus, it restores the tone of the system, and invigorates the body in a manner incredible to those who have not observed its effects. If these directions are followed, the patient may almost certainly expect a recovery, provided any degree of vital strength remains; and those who desire a life of celibacy on a moral account, will find them much more effectual than all the vows of chastity they can make.

ONCA, or ONCE, in zoology. See FELIS.

ONEGA, a river and lake of the Russian empire, between Muscovite Carelia, the territory of Cargapol, and Swedish Carelia. It is 100 miles in length and 40 in breadth, having a communication with the lake Ladoga, and consequently with Petersburgh. The river has its source in Cargapol, and gives its name to a country full of woods.

ONEGLIA, a sea-port town of Italy, in the territory of Genoa, with the title of a principality; but it belongs to the king of Sardinia, as well as the province, which abounds in olive-trees, fruit and wine. It has often been taken and retaken in the wars of Italy; which is no wonder, as it is an open place. The French and Spaniards had possession of it in 1744, but were driven out by the Piedmontese; however, they returned next winter, and again made themselves masters of it. E. Long. 8. 1. N. Lat. 43. 55.

ONEIROCRITICA, the art of interpreting dreams; or a method of foretelling future events by means of dreams. See DREAM, DIVINATION, &c.—The word is formed from the Greek ονειρος, "dream," and κριτικη, of κρισις, "judgment."—Some call it *oneirocritica;* and derive it from ονειρος, and κρατεω, "I possess, I command."

It appears from several passages of scripture, that there was, under the Jewish dispensation, such a thing as foretelling future events by dreams; but then there was a particular gift, or revelation, required for that purpose.

Hence it has been inferred, that dreams are really significative, and do forebode something to come; and all that is wanting among us is the *oneirocritica*, or the art of knowing what: yet it is the opinion of many, that dreams are mere chimeras; bearing, indeed, some relation to what has passed, but none to what is to come.—As to the case of Joseph, it was possible for God, who knew all things, to discover to him what was in the womb of fate; and to introduce that, he might take the occasion of a dream.

ONEIROCRITICS, a title given to interpreters of dreams, or those who judge of events from the circumstances of dreams.

There is no great regard to be had to those Greek books called *oneirocritics;* nor do we know why the patriarch of Constantinople, and others, should amuse themselves with writing on so pitiful a subject.

Rigault has given us a collection of the Greek and Latin works of this kind; one attributed to Astrampsichus; another to Nicephorus, patriarch of Constantinople; to which are added the treatises of Artemidorus and Achmet.—But the books themselves are little else than reveries; a kind of waking dreams, to explain and account for sleeping ones.

The secret of oneirocriticism, according to them all, consists in the relation supposed to be between the dream, and the thing signified: but they are far from keeping to the relations of agreement and similitude; and frequently have recourse to others of dissimilitude, and contrariety.

ONESIÆ THERMÆ, (Strabo;) who calls them *excellent baths*, and *salutary waters*, at the foot of the Pyrenees in Aquitania. Near the river Aturus stands at this day the town Bagneres, famous for its waters, which appear to be the *Onesiæ* of Strabo; situate in the county of Bigorre in Gascony, near the river Adour.

ONIÆ OPPIDUM and *Templum*, (Josephus); so called from Onias, the high-priest of the Jews in Egypt; who built a temple in imitation of that at Jerusalem, by permission of the king of Egypt, on the spot where stood the temple of Diana Agrestis in Leontopolis: it was encompassed with a brick wall, and had a large tower like that at Jerusalem, (Josephus:) it was the metropolis of the Nomos Heliopolites, (Ptolemy;) because in Strabo's time Heliopolis was fallen to decay.

ONGLEE, in heraldry, an appellation given to the talons or claws of beasts or birds, when borne of a different colour from that of the body of the animal.

ONION. See CEPA.—Onions, leeks, and garlic, are all of the same genus; and in their recent state are are acrid, but harmless to the human body. When, by age or climate, this acrimony is too great, we do not use them as food. In Spain, the garlic being equally mild with the onion is used as common food. By the ordinary culinary preparation their acrimony is dissipated, and a remarkably mild substance remains, promising much nutriment, which those who can digest them raw will certainly obtain. Though sometimes shunned as food, yet they are on that account used in medicine, uniting the two qualities of pectorals, viz. on the account of their acrimony, being in their recent state expectorant; in their boiled state, on account of their mucilage, demulcent, provided the quantity taken be sufficient. Some of late, in this country, have found in leeks a somniferous quality; but this is not yet confirmed by a sufficient number of experiments.—Besides the three abovementioned, there are several

feveral others belonging to the fame tribe, which we ufe as condiment; but only the leek and onion as diet. In its recent ftate, the onion is the moft acrid; in its boiled ftate, the leek retains its acrimony moft tenacioufly. On account of this, and fome difference of texture, the onion is more eafily digefted, and more univerfally ufed, than the leek; being more eafily broke down, and more generally agreeable.

ONISCUS, in zoology, a genus of infects belonging to the order of aptera. It has 14 legs, briftly feelers, and an oval body. There are 15 fpecies; of which the moft remarkable are, 1. The entomon, or fea wood-loufe, is white; eyes black; convex above, beneath flat, margin acute: Antennæ 4: Four hind pair of legs largeft, hairy. Body of 7 fegments. Length $1\frac{1}{2}$ line. Found on the coaft. It accompanies the herring, and is an enemy well known to our fifhermen: thefe infects will frequently eat up a whole fifh while it hangs in the net.—2. Afellus, millepes, or wood-loufe, is oval; the tail obtufe, with 2 undivided briftles: Various as to colour: Length, 5 lines. Their ufe in medicine is well known.

ONKELOS, furnamed the *Profelyte*, a famous rabbi of the firft century, and the author of the Chaldee Targum on the Pentateuch. He flourifhed in the time of Jefus Chrift, according to the Jewifh writers; who all agree, that he was, at leaft in fome part of his life, cotemporary with Jonathan Ben Uzziel, author of the fecond Targum upon the prophets. Dean Prideaux thinks he was the elder of the two, for feveral reafons: the chief of which is the purity of the ftyle in his Targum, therein coming neareft to that part of Daniel and Ezra which is in Chaldee, and is the trueft ftandard of that language, and confequently is the moft ancient; fince that language, as well as others, was in a conftant flux, and continued deviating in every age from the original: nor does there feem to be any reafon why Jonathan Ben Uzziel, when he underftood his Targum, fhould pafs over the law, and begin with the prophets, but that he found Onkelos had done this work before him, and with a fuccefs which he could not exceed.

Azaries, the author of a book, intitled *Meor Enaim*, or the *Light of the Eyes*, tells us, that Onkelos was a profelyte in the time of Hillel and Samnai, and lived to fee Jonathan Ben Uzziel one of the prime fcholars of Hillel. Thefe three doctors flourifhed 12 years before Chrift, according to the chronology of Gauz; who adds, that Onkelos was cotemporary with Gamaliel the elder, St Paul's mafter, who was the grandfon of Hillel, who lived 28 years after Chrift, and did not die till 18 years before the deftruction of Jerufalem. However, the fame Gauz, by his calculation, places Onkelos 100 years after Chrift; and to adjuft his opinion with that of Azarias, extends the life of Onkelos to a great length. The Talmudifts tell us that he affifted at the funeral of Gamaliel, and was at a prodigious expence to make it moft magnificent. Dean Prideaux obferves, that the Targum of Onkelos is rather a verfion than a paraphrafe; fince it renders the Hebrew text word for word, and for the moft part accurately and exactly, and is by much the beft of all this fort: and therefore it has always been held in efteem among the Jews, much above all the other Targums; and being fet to the fame mufical notes with the Hebrew text, it is thereby made capable of being read in the fame tone with it in their public affemblies. From the excellency and accuracy and Onkelos's Targum, the dean alfo concludes him to have been a native Jew, fince, without being bred up from his birth in the Jewifh religion and learning, and long exercifed in all the rites and doctrines thereof, and being alfo thoroughly fkilled in both the Hebrew and Chaldee languages, as far as a native Jew could be, he can fcarce be thought thoroughly adequate to that work which he performed; and that the reprefenting him as a profelyte, feems to have proceeded from the error of taking him to have been the fame with Akilas, or Aquila, of Pontus, author of the Greek Targum or verfion of the prophets and Hagiographia, who was indeed a Jewifh profelyte.

ONKOTOMY, in furgery, the opening of a tumour or abfcefs. See SURGERY.

ONOMANCY, or rather ONOMAMANCY, a branch of divination, which foretells the good or bad fortune of a man, from the letters in his name. See the article DIVINATION.

From much the fame principle the young Romans toafted their miftreffes as often as there were letters in their names: hence Martial fays,

Nævia fex cyathis, feptem Juftina bibatur.

ONOMATOPOEIA, in grammar and rhetoric, a figure where words are formed to refemble the found made by the things fignified; as the buzz of bees, the cackling of hens, &c.

ONOSANDER, a Greek author and Platonic philofopher, who wrote Commentaries on Plato's politics, which are loft: but his name is particularly famous for a treatife intitled Λογος Στρατηγικος, "Of the duty and virtues of the general of an army;" which has been tranflated into Latin, Italian, Spanifh, and French. The time when he lived is not precifely known; but is imagined to be in the reign of the emperor Claudius.

ONTARIO, a lake of North America, in the country of the Iroquois, 180 miles in length and 60 in breadth. There are many rivers that run into it; and from it the great river St Lawrence proceeds. It communicates with lake Erie by a river 33 miles in length, in which is the remarkable cataract of NIAGARA.

ONTOLOGY. See METAPHYSICS, n° 1.

ONUPHRIUS PANVINUS, a learned Italian, of the order of hermits of St Auguftine, was born of a noble family at Verona, in 1529; and, being trained to literature, became fo indefatigable in his ftudies, that he fpent whole days and nights in reading the ancients: which made Manutius ftyle him *Helluo Antiquitatis*. His firft performance was A Chronicle of Popes and Cardinals, which was printed without his knowledge at Venice in 1557; and fome time after, more correctly by himfelf. He afterwards continued Platina's Lives of the Popes, from Sextus IV. to Pius V. and fubjoined annotations to the lives Platina had written. He alfo wrote four pieces upon Roman Antiquities, which are printed in Grævius's Collection. He died in his 39th year, in 1568.

ONYCOMANCY, or, as fome write it, ONYMANCY; a kind of divination by means of the nails of the fingers.——The word is formed from the Greek ονυξ, "nail," and μαντεια, "divination."

The ancient practice was to rub the nails of a youth with oil and foot, or wax; and to hold up the nails thus fmeared againft the fun.—Upon them were fuppofed to appear figures or characters, which fhewed the thing required.

ONYX, in natural hiftory, one of the femipellucid gems, with varioufly coloured zones, but none red; being compofed of cryftal, debafed by a fmall admixture of earth; and made up either of a number of flat plates, or of a feries of coats furrounding a central nucleus, and feparated from each other by veins of a different colour, refembling zones or belts.

We have four fpecies of this gem. 1. A bluifh-white one, with broad white zones. 2. A very pure onyx, with fnow-white veins. 3. The jafponyx, or horny-onyx, with green zones. 4. The brown onyx, with bluifh-white zones.

The ancients attributed wonderful properties to the onyx, and imagined that if worn on the finger it acted as a cardiac; they have alfo recommended it as an aftringent: but at prefent no regard is paid to it.

The word in the Greek language fignifies *nail;* the poets making this ftone to have been formed by the Parcæ, from a piece of Venus's nails, cut off by Cupid with one of his arrows.

OOST, a kiln for drying hops after they are picked from the ftalks.

OPACITY, in philofophy, a quality of bodies which renders them impervious to the rays of light.

OPAL, in natural hiftory, a fpecies of the chroaftaces genus of gems.

The opal is a gem of a very peculiar kind, and has been efteemed by many in all ages of very great value; though at prefent it is of lefs value, in proportion to its fize, than any of the finer gems. It is fofter than any other of the fine gems, and is difficult to polifh to any degree of nicety. It is found of various fhapes and fizes; its moft frequent bignefs is between that of a pea and a horfe-bean; but it is found as fmall as the head of a large pin, and has been feen of the fize of a large walnut. Its figure is very various and uncertain, but it is never found in a cryftalliform or columnar ftate; its moft ufual fhape is an irregular oblong one, convex above, flatted at bottom, and dented with various finuofities at its fides. It is often found among the loofe earth of mountains, fometimes on the fhores of rivers, and not unfrequently bedded in the coarfer kinds of jafper. It is found in Egypt, Arabia, fome parts of the Eaft Indies, and in many parts of Europe: thofe of Europe are principally from Bohemia, and are of a greenifh or greyifh colour; the colour of the other opals much refembles the fineft mother of pearl, its bafis feeming a bluifh or greyifh white, but with a property of reflecting all the colours of the rainbow, as turned differently to the light.

OPALIA, in antiquity, feafts celebrated at Rome in honour of the goddefs Ops. Varro fays they were held on the 19th of December, which was one of the days of the faturnalia: thefe two feafts were celebrated in the fame month, becaufe Saturn and Ops were hufband and wife: the vows offered to the goddefs were made fitting on the ground.

OPERA, a dramatic compofition fet to mufic, and fung on the ftage, accompanied with mufical inftruments, and enriched with magnificent dreffes, machines, and other decorations. See POETRY, ch. ii. and MUSIC, n° 26.

OPERATION, in general, the act of exerting or exercifing fome power or faculty, upon which an effect follows.

OPERATION, in furgery and medicine, denotes a methodical action of the hand on the human body, in order to re-eftablifh health.

OPHIDIUM, a genus of fifhes belonging to the order of apodes. The head is fomewhat naked; the teeth are in the jaws, palate, and fauces; there are feven rays in the gill-membranes; and the body is fhaped like a fword. There are two fpecies.

OPHIOGLOSSUM, ADDER'S-TONGUE; a genus of the order of filices, belonging to the cryptogamia clafs of plants. There are feven fpecies; of which the only remarkable one is the vulgatum, or common adder's-tongue, which is a native of feveral places of Britain, growing in meadows and moift paftures. The country-people make an ointment of the frefh leaves, and ufe it as a vulnerary to green wounds; which is a very ancient application, recommended by Matthiolus, Tragus, and others.

OPHIOMANCY, in antiquity, the art of making predictions from ferpents. Thus Calchas, on feeing a ferpent devour eight fparrows with their dam, foretold the duration of the fiege of Troy: and the feven coils of a ferpent that was feen on Anchifes's tomb, were interpreted to mean the feven years that Æneas wandered from place to place before he arrived at Latium.

OPHIORHIZA, in botany, a genus of the monogynia order, belonging to the pentandria clafs of plants. There are two fpecies; the moft remarkable of which is the Afiaticum, or true lignum colubrinum. The root of this is known in the Eaft Indies to be a fpecific againft the poifon of that moft dreadful animal called the *hooded ferpent*. There is a treatife in *Amœn. Acad.* tom. iv. upon this fubject, wherein the author Joh. And. Darelius undertakes, from the defcription of fuch authors as had feen it upon the fpot, to afcertain the plant from which the genuine root is taken. It appears in this account, that it had puzzled the European phyficians; and what had been fold in the fhops for it, is the root of a very different plant, and of a poifonous nature.

The true root is called *mungus*, for the following reafon.—There is a kind of weafel in the Eaft Indies, called *mungutia* by the natives, *mungo* by the Portuguefe, and *muncas* by the Dutch. This animal purfues the hooded ferpent, as the cat does the moufe with us. As foon as this ferpent appears, the weafel attacks him; and if fhe chances to be bit by him, fhe immediately runs to find a certain vegetable, upon eating which fhe returns, and renews the fight.—The Indians are of opinion that this plant is the mungos.

That celebrated traveller Kempfer, who kept one of thefe weafels tame, that eat with him, lived with him, and was his companion wherever he went, fays he faw one of thefe battles between her and the ferpent, but could not certainly find out what root the weafel looked out for. But whether the weafel firft difcovered this antidote or not, it is an infallible remedy

remedy againſt the bite of the hooded ſerpent. And this he undertakes to aſcertain.

OPHITES, in natural hiſtory, a ſort of variegated marble, of a duſky-green ground, ſprinkled with ſpots of a lighter green, otherwiſe called *ſerpentine*. See the article MARBLE.

OPHITES, in church-hiſtory, Chriſtian heretics, ſo called both from the veneration they had for the ſerpent that tempted Eve, and the worſhip they paid to a real ſerpent: they pretended that the ſerpent was Jeſus Chriſt, and that he taught men the knowledge of good and evil. They diſtinguiſhed between *Jeſus* and *Chriſt:* Jeſus, they ſaid, was born of the Virgin, but Chriſt came down from heaven to be united with him; Jeſus was crucified, but Chriſt had left him to return to heaven. They diſtinguiſhed the God of the Jews, whom they termed *Jaldabaoth*, from the ſupreme God: to the former they aſcribed the body, to the latter the ſoul of men. They had a live ſerpent, which they kept in a kind of cage; at certain times they opened the cage-door, and called the ſerpent: the animal came out, and, mounting upon the table, twined itſelf about ſome loaves of bread; this bread they broke and diſtributed it to the company, who all kiſſed the ſerpent: this they called their *Euchariſt*.

OPHIR, a country mentioned in ſcripture, from which Solomon had great quantities of gold brought home in ſhips which he ſent out for that purpoſe; but where to fix its ſituation is the great difficulty, authors running into various opinions on that head. Some have gone to the Weſt, others to the Eaſt Indies, and the eaſtern coaſts of Africa, in ſearch of it. The generality place Ophir in the Eaſt Indies: but where there, is the queſtion; many taking it for Taphrobana, now ſuppoſed to be Ceylon; others for Pegu, or for Sumatra; or for the Aurea Cherſoneſus, now Malacca: unleſs *Aurea Cherſoneſus* be, as many think, an appellative common to all countries producing gold. Kircher takes the term *Ophir* to be of Egyptian original, and to denote a great part of India: and, to obviate difficulties, perhaps it is beſt to take *Ophir* for India at large, without confining it to any particular country, not excluding even China and the Japaneſe iſlands.

OPHRYS, TWYBLADE; a genus of the diandria order, belonging to the gynandria claſs of plants. The ſpecies are numerous; but the moſt remarkable are the following.

1. The ovata, oval-leaved ophrys, or common twyblade, hath a bulbous, fibrated root; crowned by two oval, broad, obtuſe, veined, oppoſite leaves; an erect, ſucculent, green ſtalk, ſix or eight inches high, naked above, and terminated by a looſe ſpike of greeniſh flowers, having the lip of the nectarium bifid. The flowers of this ſpecies reſemble the figure of gnats. 2. The ſpiralis, ſpiral orchis, or triple ladies-treſſes, hath bulbous, oblong, aggregated roots; crowned by a cluſter of oval, pointed, ribbed leaves; erect ſimple ſtalks, half a foot high; terminated by long ſpikes of white odoriferous flowers, hanging to one ſide, having the lip of the nectarium entire, and crenated. 3. The nidus-avis, or bird's-neſt, hath a bulboſe, fibrated, cluſtered root; upright, thick, ſucculent ſtalks, a foot high, ſheathed by the leaves, and terminated by looſe ſpikes of pale-brown flowers; having the lip of the nectarium bifid. 4. The anthropophora, man-ſhaped ophrys, or man-orchis, hath a roundiſh bulboſe root, crowned with three or four oblong leaves; upright thick ſtalks, riſing a foot and a half high; adorned with narrow leaves, and terminated by looſe ſpikes of greeniſh flowers, repreſenting the figure of a naked man; the lip of the nectarium linear tripartite, with the middle ſegment longeſt and bifid. There is a variety with browniſh flowers tinged with green. 5. The inſectifera, or inſect-orchis, hath two roundiſh bulbous roots, crowned with oblong leaves; erect leafy ſtalks, from ſix to 10 or 12 inches high, terminated by ſpikes of inſect-ſhaped greeniſh flowers, having the lip of the nectarium almoſt five-lobed. This wonderful ſpecies exhibit flowers in different varieties, that repreſent ſingular figures of flies, bees, and other inſects; and are of different colours in the varieties. 6. The monorchis, or muſky ophrys, hath a roundiſh bulboſe root; crowned with three or four oblong leaves; an erect naked ſtalk, ſix inches high; terminated by a looſe ſpike of yellowiſh, muſky-ſcented flowers.

All theſe ſix ſpecies of ophrys flower in ſummer, at different times in different ſorts, from May until July; and in moſt of the ſorts exhibit a ſingularly curious appearance. The plants are all perennial in root, which are of the bulbous fleſhy kind, from which the flower-ſtalks riſe annually in ſpring, and decay in autumn; at which period is the proper time for removing the roots from one place to another. They all grow wild in Britain, &c.; are reſidents of woods, bogs, marſhy grounds, ſterile paſtures, chalky ſoils, and the like places, where they flouriſh and diſplay their ſingular flowers in great abundance, from which places they are introduced into gardens for variety; and having procured ſome plants at the proper ſeaſon, and planted them in ſoils and ſituations ſomewhat ſimilar to that where they naturally grow, the roots will abide for ſeveral years, and flower annually.

As to their propagation, it may be tried by ſeed in a ſhady border, as ſoon as it is ripe; likewiſe by off-ſets from the root, though they multiply ſparingly in gardens: however, roots of ſome ſtanding may be examined at the proper ſeaſon, and any off-ſets ſeparated and planted in the proper places.

OPHTHALMOSCOPY, a branch of phyſiognomy, which deduces the knowledge of a man's temper and manner from the appearance of his eyes.

OPHTHALMIA, in medicine, an inflammation of the membranes which inveſt the eye; eſpecially of the adnata, or albugineous coat. See MEDICINE, n° 283.

OPIATES, medicines of a thicker conſiſtence than a ſyrup, prepared with opium ſcarcely fluid. They conſiſt of various ingredients, made up with honey or ſyrup; and are to be uſed for a long time either for purgative, alterative, or corroborative intentions.

The word *opiate* is alſo uſed, in general, for any medicine given with an intention to procure ſleep, whether in the form of electuaries, drops, or pills.

OPITS, or OPITIUS (Martin), a celebrated German poet, born at Breſlaw in 1507. He acquired great fame by his Latin, and more by his German poems; and, retiring to Dantzic, wrote a hiſtory of the ancient

ancient Daci: he died of the plague in 1639.

Opits (Henry), a learned Lutheran divine, born at Altenburg in Misnia in 1642. He was professor of theology and of the oriental languages at Kiel, where he acquired great reputation by a variety of excellent works concerning oriental literature and Hebrew antiquities. He died in 1712.

OPIUM, in the materia medica, is an inspissated juice, partly of the resinous and partly of the gummy kind, brought to us in cakes from eight ounces to a pound weight. It is very heavy, of a dense texture, and not perfectly dry; but, in general, easily receives an impression from the finger: its colour is a brownish yellow, so very dark and dusky that at first it appears black: it has a dead and faint smell, and its taste is very bitter and acrid. It is to be chosen moderately firm, and not too soft; its smell and taste should be very strong, and care is to be taken that there be no dirty or stony matter in it.

Opium is the juice of the papaver album, or white poppy, with which the fields of Asia Minor are in many places sown, as ours are with corn. When the heads are near ripening, they wound them with an instrument that has five edges, which on being stuck into the head makes at once five long cuts in it; and from these wounds the opium flows, and is next day taken off by a person who goes round the field, and put up in a vessel which he carries fastened to his girdle; at the same time that this opium is collected, the opposite side of the poppy-head is wounded, and the opium collected from it the next day. They distinguish, however, the produce of the first wounds from that of the succeeding ones; for the first juice afforded by the plant is greatly superior to what is obtained afterwards. After they have collected the opium, they moisten it with a small quantity of water or honey, and work it a long time upon a flat, hard, and smooth board, with a thick and strong instrument of the same wood, till it becomes of the consistence of pitch; and then work it up with their hands, and form it into cakes or rolls for sale.

Opium at present is in great esteem, and is one of the most valuable of all the simple medicines. Applied externally, it is emollient, relaxing, and discutient, and greatly promotes suppuration: if long kept upon the skin, it takes off the hair, and always occasions an itching in it; sometimes is exulcerates it, and raises little blisters, if applied to a tender part. Sometimes, on external application, it allays pain, and even occasions sleep: but it must by no means be applied to the head, especially to the sutures of the skull; for it has been known to have the most terrible effects in this application, and even to bring on death itself. Opium, taken internally, removes melancholy, eases pain, and disposes to sleep; in many cases removes hæmorrhages, and provokes sweating. A moderate dose is commonly under a grain; though, according to the circumstances, two grains, or even three, may be within the limits of this denomination: but custom will make people bear a dram or more; though in this case nature is vitiated, and nothing is to be hence judged in regard to others. If given dissolved, it operates in half an hour; if in a solid form, as in pills, or the like, it is sometimes an hour and a half. Its first effect, in this case, is the making the patient cheerful, as if he had drank moderately of wine, and at the same time bold and above the fear of danger; for which reason the Turks always take it when they are going to battle. A very immoderate dose brings on a sort of drunkenness, much like that occasioned by an immoderate quantity of strong liquors; cheerfulness and loud laughter at first, than a relaxation of the limbs, a loss of memory, and lightheadedness; then vertigoes, dimness of the eyes, with a laxity of the cornea and a dilatation of the pupils, a slowness of the the pulse, redness of face, relaxation of the under-jaws, swelling of the lips, difficulty of breathing, painful erection of the penis, convulsions, cold sweat, and finally death. Those who escape are usually relieved by a great number of stools, or profuse sweats.

OPOBALSAMUM, in the materia medica. Opobalsam, or balm of Gilead; a resinous juice, obtained from an evergreen tree, or shrub, growing spontaneously in Arabia. The best sort, which naturally exsudes from the plant, is scarce known to Europe; and the inferior kinds, said to be extracted by lightly boiling the leaves and branches in water, are very rarely seen among us. The true opobalsam, according to Alpinus, is at first turbid and white; of a very strong pungent smell, like that of turpentine, but much sweeter; and of a bitter, acrid, astringent taste; upon being kept for some times it becomes thin, limpid, light, of a greenish hue; then of a gold yellow; and at length of the colour of honey: after this it grows thick like turpentine, and loses much of its fragrance. This balsam is of great esteem in the eastern countries, both as a medicine, and as an odoriferous unguent and cosmetic. Its great scarcity has prevented its coming into use among us; in the mithridate and theriaca, which it is directed as an ingredient in, the London college allows the expressed oil of nutmegs as a succedaneum to it.

OPOPANAX, in the materia medica, is a gum resin of a tolerably firm texture, usually brought to us in loose granules or drops, and sometimes in large masses, formed of a number of these connected by a quantity of matter of the same kind; but these are usually loaded with extraneous matter, and are greatly inferior to the pure loose kind. The drops or granules of the fine opopanax, are on the outside of a brownish red colour, and of a dusky yellowish or whitish colour within: they are of a somewhat unctuous appearance, smooth on the surface; and are to be chosen in clear pieces, of a strong smell and acrid taste.

Opopanax is attenuating and discutient, and is gently purgative; it dispels flatulencies, and is good in asthmas, in inveterate coughs, and in disorders of the head and nerves. It also promotes the menses, and is good against all obstructions of the viscera.

OPOSSUM, in zoology. See Didelphis.

OPPIANUS, a poet and grammarian of Anazarba in Cilicia, in the second century. He composed a poem of hunting, and another of fishing, for which Antoninus Caracalla gave him as many golden crowns as their were verses in his poems; they were called hence *Oppian's golden verses*. He died in the 30th year of his age.

OPPILATION, in medicine, the act of obstructing or stopping up the passages of the body, by redundant

dundant or peccant humours. This word is chiefly uſed for obſtructions in the lower belly.

OPTATIVE MOOD, in grammar, that which ſerves to expreſs an ardent deſire or wiſh for ſomething.

In moſt languages, except the Greek, the optative is only expreſſed by prefixing to the ſubjunctive an adverb of wiſhing; as *utinam*, in Latin; *plut a Dieu*, in French; and *would to God*, in Engliſh.

OPTIC ANGLE, the angle which the optic axes of both eyes make with one another, as they tend to meet at ſome diſtance before the eyes.

OPTIC *Axis*, the axis of the eye, or a line going through the middle of the pupil, and the centre of the eye.

OPTICS;

THAT ſcience which treats of element of the light, and the various phenomena of viſion.

HISTORY.

§ 1. *Diſcoveries concerning the Light.*

THESE are enumerated under the article LIGHT ſo fully, that there is little room for any further addition here. The nature of that ſubtile element is indeed very little known as yet, notwithſtanding all the endeavours of philoſophers; and whatever ſide is taken with regard to it, whether we ſuppoſe it to conſiſt of an infinity of ſmall particles propagated by a repulſive power from the luminous body, or whether we ſuppoſe it to conſiſt in the vibrations of a ſubtile fluid, there are prodigious difficulties, almoſt, if not totally inſuperable, which will attend the explanation of its phenomena. In many parts of this work the identity of light and of the electric fluid is aſſerted: this, however, doth not in the leaſt interfere with the phenomena of optics; all of which are guided by the ſame invariable laws, whether we ſuppoſe light to be a vibration of that fluid, or any thing elſe. We ſhall therefore proceed to,

1 Great difficulties attend the explanation of the phenomena of light.

§ 2. *Diſcoveries concerning the Refraction of Light.*

2 Refraction known to the ancients.

WE find that the ancients, though they made very few optical experiments, nevertheleſs knew, that when light paſſed through mediums of different denſities, it did not move forward in a ſtraight line, but was bent, or *refracted*, out of its courſe. This was probably ſuggeſted to them by the appearance of a ſtraight ſtick partly immerſed in water: and we find many queſtions concerning this and other optical appearances in Ariſtotle; to which, however, his anſwers are inſignificant. Archimedes is even ſaid to have written a treatiſe concerning the appearance of a ring or circle under water, and therefore could not have been ignorant of the common phenomena of refraction. But the ancients were not only acquainted with theſe more ordinary appearances of refraction, but knew alſo the production of colours by refracted light. Seneca ſays, that if the light of the ſun ſhines through an angular piece of glaſs, it will ſhew all the colours of the rainbow. Theſe colours, however, he ſays are falſe, ſuch as are ſeen in a pigeon's neck when it changes its poſition; and of the ſame nature he ſays is a ſpeculum, which, without having any colour of its own, aſſumes that of any other body. It appears alſo, that the ancients were not unacquainted with the magnifying power of glaſs globes filled with water, though they do not ſeem to have known any thing of the reaſon of this power; and the ancient engravers are ſuppoſed to have made uſe of a glaſs globe filled with water to magnify their figures, and thereby to work to more advantage. That the power of tranſparent bodies of a ſpherical form in magnifying or burning was not wholly unknown to the ancients, is farther probable from certain gems preſerved in the cabinets of the curious, which are ſuppoſed to have belonged to the Druids. They are made of rock-cryſtal of various forms, amongſt which are found ſome that are lenticular and others that are ſpherical: and though they are not ſufficiently wrought to perform their office as well as they might have done if they had been more judiciouſly executed, yet it is hardly poſſible that their effect, in magnifying at leaſt, could have eſcaped the notice of thoſe who had often occaſion to handle them; if indeed, in the ſpherical or lenticular form, they were not purpoſely intended for the purpoſes of burning. One of theſe, of the ſpherical kind, of about an inch and a half diameter, is preſerved among the foſſils given to the univerſity of Cambridge by Dr Woodward.

3 And the magnifying power of glaſs-globes.

4 Refraction firſt treated of by Ptolemy.

The firſt treatiſe of any note written on the ſubject of optics, was by the celebrated aſtronomer Claudius Ptolomæus, who lived about the middle of the ſecond century. The treatiſe is loſt; but from the accounts of others we find that he treated of aſtronomical refractions. Though refraction in general had been obſerved very early, it is poſſible that it might not have occurred to any philoſophers much before his time, that the light of the ſun, moon, and ſtars muſt undergo a ſimilar refraction, in conſequence of falling obliquely upon the groſs atmoſphere that ſurrounds the earth; and that they muſt, by that means, be turned out of their rectilinear courſe, ſo as to cauſe thoſe luminaries to appear higher in the heavens than they would otherwiſe do. The firſt aſtronomers were not aware that the intervals between ſtars appear leſs near the horizon than in the meridian; and, on this account, they muſt have been much embarraſſed in their obſervations. But it is evident that Ptolemy was aware of this circumſtance, by the caution that he gives to allow ſomething for it, upon every recourſe to ancient obſervations.

2 His hypotheſis concerning the horizontal ſun and moon.

This philoſopher alſo advances a very ſenſible hypotheſis to account for the remarkably greater apparent ſize of the ſun and moon when ſeen near the horizon. The mind, he ſays, judges of the ſize of objects by means of a pre-conceived idea of their diſtance from us: and this diſtance is fancied to be greater when a number of objects are interpoſed between the eye and the body we are viewing; which is the caſe when we ſee the heavenly bodies near the horizon. In his Almageſt, however, he aſcribes this appearance to a refraction

fraction of the rays by vapours, which actually enlarge the angle under which the luminaries appear; juſt as the angle is enlarged by which an object is ſeen from under water.

6 Diſcoveries of Alhazen.

In the 12th century, the nature of refraction was largely conſidered by Alhazen an Arabian writer; in ſo much that, having made experiments upon it at the common ſurface between air and water, air and glaſs, water and glaſs or cryſtal; and, being prepoſſeſſed with the ancient opinion of cryſtalline orbs in the regions above the atmoſphere, he even ſuſpected a refraction there alſo, and fancied he could prove it by aſtronomical obſervations. This author deduces from hence ſeveral properties of atmoſpherical refraction, as that it increaſes the altitudes of all objects in the heavens; and he firſt advanced, that the ſtars are ſometimes ſeen above the horizon by means of refraction, when they are really below it. This obſervation was confirmed by Vitellio, B. Waltherus, and eſpecially by the excellent obſervations of Tycho Brahe. Alhazen obſerved, that refraction contracts the diameters and diſtances of the heavenly bodies, and that it is the cauſe of the twinkling of the ſtars. But we do not find that either he, or his follower Vitellio, knew any thing of its juſt quantity. Indeed it is too ſmall to be determined except by very accurate inſtruments, and therefore we hear little more of it till about the year 1500; at which time great attention was paid to it by Bernard Walther, Mæſtlin, and others, but chiefly by Tycho Brahe.

Alhazen ſuppoſed that the refraction of the atmoſphere did not depend upon the vapours in it, as was probably the opinion of philoſophers before his time, but on the different tranſparency; by which, as Montucla conjectures, he meant the denſity of the groſs air contiguous to the earth, and the ether or ſubtile air that lies beyond it. In examining the effects of refraction, he endeavours to prove that it is ſo far from being the cauſe of the heavenly bodies appearing larger near the horizon, that it would make them appear leſs; two ſtars, he ſays, appearing nearer together in the horizon, than near the meridian. This phenomenon he ranks among optical deceptions. We judge of diſtance, he ſays, by comparing the angle under which objects appear, with their ſuppoſed diſtance; ſo that if theſe angles be nearly equal, and the diſtance of one object be conceived greater than that of the other, it will be imagined to be larger. And the ſky near the horizon he ſays is always imagined to be further from us than any other part of the concave ſurface. Roger Bacon aſcribes this account of the horizontal moon to Ptolemy; and as ſuch it is examined, and objected to by B. Porta.

In the writings of this philoſopher we find the firſt diſtinct account of the magnifying power of glaſſes; and it is not improbable, that what he wrote upon this ſubject gave riſe to that moſt uſeful invention of ſpectacles. For he ſays, that if an object be applied cloſe to the baſe of the larger ſegment of a ſphere of glaſs, it will appear magnified. He alſo treats of the appearance of an object through a globe, and ſays that he was the firſt who obſerved the refraction of rays into it.

7 Of Vitellio.

In 1270, Vitellio, a native of Poland, publiſhed a treatiſe of optics, containing all that was valuable in Alhazen, and digeſted in a much more intelligible and methodical manner. He obſerves, that light is always loſt by refraction, in conſequence of which the objects ſeen by refracted light always appear leſs luminous; but he does not pretend to eſtimate the quantity of this loſs. He reduced into a table the reſult of his experiments on the refractive powers of air, water, and glaſs, correſponding to different angles of incidence. In his account of the horizontal moon he agrees exactly with Alhazen; obſerving, that in the horizon ſhe ſeems to touch the earth, and appears much more diſtant from us than in the zenith, on account of the intermediate ſpace containing a greater variety of objects upon the viſible ſurface of the earth. He aſcribes the twinkling of the ſtars to the motion of the air in which the light is refracted; and to illuſtrate this hypotheſis, he obſerves, that they twinkle ſtill more when viewed in water put in motion. He alſo ſhews, that refraction is neceſſary as well as reflection, to form the rainbow; becauſe the body which the rays fall upon is a tranſparent ſubſtance, at the ſurface of which one part of the light is always reflected and another refracted. But he ſeems to conſider refraction as ſerving only to condenſe the light, and thereby enabling it to make a ſtronger impreſſion upon the eye. This writer alſo makes ſome ingenious attempts to explain refraction, or to aſcertain the law of it. He alſo conſiders the foci of glaſs ſpheres, and the apparent ſize of objects ſeen through them; though upon theſe ſubjects he is not at all exact. It is ſufficient indeed to ſhew the ſtate of knowledge, or rather of ignorance, at that time, to obſerve, that both Vitellio, and his maſter Alhazen, endeavour to account for objects appearing larger when they are ſeen under water by the circular figure of its ſurface; ſince, being fluid, it conforms to the figure of the earth.

8 Of Roger Bacon.

Cotemporary with Vitellio was Roger Bacon, a man of very extenſive genius, and who wrote upon almoſt every branch of ſcience; yet he does not ſeem to have made any conſiderable advances beyond what Alhazen had done before him. Even ſome of the wildeſt and moſt abſurd of the opinions of the ancients have had the ſanction of his authority. He does not heſitate to aſſent to an opinion adopted by many of the ancients, and indeed by moſt philoſophers till his time, that viſual rays proceed from the eye; giving this reaſon for it, that every thing in nature is qualified to diſcharge its proper functions by its own powers, in the ſame manner as the ſun and other celeſtial bodies. In his *Specula Mathematica*, he added ſome obſervations on the refraction of the light of the ſtars; the apparent ſize of objects; the extraordinary ſize of the ſun and moon in the horizon: but in all this he is not very exact, and advances but little. In his *Opus Majus* he demonſtrates, that if a tranſparent body interpoſed between the eye and an object, be convex towards the eye, the object will appear magnified. This obſervation, however, he certainly had from Alhazen; the only difference between them is, that Bacon prefers the ſmaller ſegment of a ſphere, and Alhazen the larger, in which the latter certainly was right.

9 Of Maurolycus.

From this time, to that of the revival of learning in Europe, we have no farther treatiſe on the ſubject of refraction, or indeed on any other part of optics. One of the firſt who diſtinguiſhed himſelf in this way was, Maurolycus teacher of mathematics at Meſſina. In a treatiſe

treatife, *De Lumine et Uumbra*, publifhed in 1575, he demonftrates that the cryftalline humour of the eye is a lens that collects the rays of light iffuing from the objects, and throws them upon the retina where is the focus of each pencil. From this principle he difcovered the reafon why fome people were fhort-fighted and others long-fighted; and why the former are relieved by concave, and the others by convex, glaffes.

10 Difcoveries of B. Porta.

About the fame time that Maurolycus made fuch advances towards the difcovery of the nature of vifion, Joannes Baptifta Porta of Naples difcovered the *camera obfcura*, which throws ftill more light on the fame fubject. His houfe was conftantly reforted to by all the ingenious perfons at Naples, whom he formed into what he called *an academy of fecrets*; each member being obliged to contribute fomething that was not generally known, and might be ufeful. By this means he was furnifhed with materials for his *Magia Naturalis*, which contains his account of the *camera obfcura*, and the firft edition of which was publifhed, as he informs us, when he was not quite 15 years old. He alfo gave the firft hint of the magic lantern; which Kircher afterwards followed and improved. His experiments with the *camera obfcura* convinced him, that vifion is performed by the intromiffion of fomething into the eye, and not by vifual rays proceeding from the eye as had been formerly imagined; and he was the firft who fully fatisfied himfelf and others upon this fubject. Indeed the refemblance between experiments with the *camera obfcura* and the manner in which vifion is performed in the eye, was too ftriking to efcape the obfervation of a lefs ingenious perfon. But when he fays that the eye is a *camera obfcura*, and the pupil the hole in the window-fhutter, he was fo far miftaken as to fuppofe that it was the cryftalline humour that correfponds to the wall which receives the images; nor was it difcovered till the year 1604, that this office is performed by the retina. He makes a variety of juft obfervations concerning vifion; and particularly explains feveral cafes in which we imagine things to be without the eye, when the appearances are occafioned by fome affection of the eye itfelf, or fome motion within the eye. He obferves alfo, that, in certain circumftances, vifion will be affifted by convex or concave glaffes; and he feems alfo to have made fome fmall advances towards the difcovery of telefcopes. He takes notice, that a round and flat furface plunged into water, will appear hollow as well as magnified to an eye perpendicularly over it; and he very well explains by a figure, the manner in which it is done.

11 The law of refraction difcovered.

All this time, however, the great problem concerning the meafuring of refractions had remained unfolved. Alhazen and Vitellio, indeed, had attempted it; but failed, by attempting to meafure the angle itfelf, inftead of its fine. At laft, however, it was difcovered by Snellius, profeffor of mathematics at Leyden. This philofopher, however, did not perfectly underftand his own difcovery, nor did he live to publifh any account of it himfelf. It was afterwards explained by profeffor Hortenfius both publicly and privately, before it appeared in the writings of Defcartes, who publifhed it under a different form, without making any acknowledgement of his obligations to Snellius, whofe papers Huygens affures us, from his own knowledge, Defcartes had feen.

12 Opinions of Defcartes and Leibnitz on this fubject.

It does not appear that, before Defcartes, any perfon attempted to explain the caufe of refraction; which he undertook to do by the refolution of forces, on the principles of mechanics. In confequence of this, he was obliged to fuppofe that light paffes with more eafe through a denfe medium, than through a rare one. The truth of this explanation was firft queftioned by M. Fermat, counfellor to the parliament of Thouloufe, and an able mathematician. He afferted, contrary to the opinion of Defcartes, that light fuffers more refiftance in water than air, and more in glafs than in water; and he maintained, that the refiftance of different mediums with refpect to light is in proportion to their denfities. M. Leibnitz adopted the fame general idea; and thefe gentlemen argued upon the fubject in the following manner.

Nature, fay they, accomplifhes her ends by the fhorteft methods. Light therefore ought to pafs from one point to another, either by the fhorteft road, or that in which the leaft time is required. But it is plain that the line in which light paffes, when it falls obliquely upon a denfer medium, is not the moft direct or the fhorteft; fo that it muft be that in which the leaft time is fpent. And whereas it is demoftrable, that light falling obliquely upon a denfer medium (in order to take up the leaft time poffible in paffing from a point in one medium to a point in the other) muft be refracted in fuch a manner, that the fines of the angles of incidence and refraction muft be to one another, as the different facilities with which light is tranfmitted in thofe mediums; it follows, that fince light approaches the perpendicular when it paffes obliquely from air into water, fo that the fine of the angle of refraction is lefs than that of the angle of incidence, the facility with which water fuffers light to pafs through it is lefs than that of the air; fo that light meets with more refiftance in water than air.

13 Difcoveries concerning the refraction of different fubftances.

Arguments of this kind could not give fatisfaction; and a little time fhewed the fallacy of the hypothefis. At a meeting of the Royal Society, Aug. 31. 1664. an experiment for meafuring the refraction of common water was made with a new inftrument which they had prepared for that purpofe; and, the angle of incidence being 40 degrees, that of refraction was found to be 30. About this time alfo we find the firft mention of mediums not refracting the light in an exact proportion to their denfities. For Mr Boyle, in a letter to Mr Oldenburgh, dated Nov. 3. 1664, obferves, that in fpirit-of-wine, the proportion of the fines of the angles of incidence to the fines of the angles of refraction was nearly the fame, viz. as 4 to 3; and that, as fpirit-of-wine occafions a greater refraction than common water, fo oil of turpentine, which is lighter than fpirit-of-wine, produces not only a greater refraction than common water, but a much greater than falt water. And at a meeting held Nov. 9. the fame year, Dr Hooke (who had been ordered to profecute the experiment) brought in an account of one that he had made with pure and clear fallad oil, which was found to have produced a much greater refraction than any liquor which he had then tried; the angle of refraction that anfwered to an angle of incidence of 30° being found no lefs than 40° 30′, and the angle of refraction that anfwered to an angle of incidence of 20° being 29° 47′.—M. de la Hire alfo made

made feveral experiments to afcertain the refractive power of oil with refpect to that of water and air, and found the fine of the angle of incidence to that of refraction to be as 60 to 42; which, he obferves, is a little nearer to that of glafs than to that of water, though oil is much lighter than water, and glafs much heavier.

The members of the Royal Society finding that the refraction of falt water exceeded that of frefh, purfued the experiment farther with folutions of vitriol, faltpetre, and alum, in water; when they found the refraction of the folution of vitriol and faltpetre a little more, but that of alum a little lefs, than common water.

Dr Hooke made an experiment before the Royal Society, Feb. 11. 1663, which clearly proves that ice refracts the light lefs than water; which he took to be a good argument that the lightnefs of ice, which caufes it to fwim in water, is not caufed only by the fmall bubbles which are vifible in it, but that it arifes from the uniform conftitution or general texture of the whole mafs. M. de la Hire alfo took a good deal of pains to determine whether, as was then the common opinion, the refractive power of ice and water were the fame; and he found, as Dr Hooke had done before, that ice refracts lefs than water.

By a moft accurate and elaborate experiment made in the year 1698, in which a ray of light was tranfmitted through a Torricellian vacuum, Mr Lowthorp found, that the refractive power of air is to that of water as 36 to 34,400. He concludes his account of the experiment with obferving, that the refractive power of bodies is not proportioned to the denfity, at leaft not to the gravity, of the refracting medium. For the refractive power of glafs to that of water, is as 55 to 34, whereas its gravity is as 87 to 34; that is, the fquares of their refractive powers are very nearly as their refpective gravities. And there are fome fluids, which, though they are lighter than water, yet have a greater power of refraction. Thus the refractive power of fpirit-of-wine, according to Dr Hooke's experiment, is to that of water as 36 to 33, and its gravity reciprocally as 33 to 36, or $36\frac{1}{2}$. But the refractive powers of air and water feem to obferve the fimple proportion of their gravities directly. And if this fhould be confirmed by fucceeding experiments, it is probable, he fays, that the refractive powers of the atmofphere are every-where, and at all heights above the earth, proportioned to its denfity and expanfion: and then it would be no difficult matter to trace the light through it, fo as to terminate the fhadow of the earth; and, together with proper expedients for meafuring the quantity of light illuminating an opaque body, to examine at what diftances the moon muft be from the earth to fuffer eclipfes of the obferved durations.

Caffini the younger happened to be prefent when Mr Lowthorp made the abovementioned experiment before the Royal Society; and upon his return home, having made a report of it to the members of the Royal Academy of Sciences, thofe gentlemen endeavoured to repeat the experiment in 1700; but they did not fucceed.—For, as they faid, beams of light paffed through the vacuum without fuffering any refraction. The Royal fociety being informed of this, were defirous that it might be put paft difpute, by repeated and well-attefted trials; and ordered Mr Haukfbee to make an inftrument for the purpofe, by the direction of Dr Halley. It confifted of a ftrong brafs prifm, two fides of which had fockets to receive two plane glaffes, whereby the air in the prifm might either be exhaufted or condenfed. The prifm had alfo a mercurial gage fixed to it, to difcover the denfity of the contained air; and was contrived to turn upon its axis, in order to make the refractions equal on each fide when it was fixed to the end of a telefcope. The refracting angle was near 64°; and the length of the telefcope was about 10 feet, having a fine hair in its focus. The event of this accurate experiment was as follows:

Having chofen a proper and very diftinct erect object, whofe diftance was 2588 feet, June 15. O. S. 1708, in the morning, the barometer being then at 29. $7\frac{1}{2}$, and the thermometer at 60, they firft exhaufted the prifm, and then applying it to the telefcope, the horizontal hair in the focus covered a mark on the object diftinctly feen through the vacuum, the two glaffes being equally inclined to the vifual ray. Then admitting the air into the prifm, the object was feen to rife above the hair gradually as the air entered, and in the end the hair was obferved to hide a mark $10\frac{1}{4}$ inches below the former mark. This they often repeated, and with the fame fuccefs.

After this they applied the condenfing engine to the prifm; and having forced in another atmofphere, fo that the denfity of the included air was double to to that of the outward, they again placed it before the telefcope, and, letting out the air, the object which before feemed to rife, appeared gradually to defcend, and the hair at length refted on an object higher than before by the fame interval of $10\frac{1}{4}$ inches. This experiment they likewife frequently repeated, without any variation in the event.

They then forced in another atmofphere; and upon difcharging the condenfed air, the object was feen near 21 inches lower than before.

Now the radius in this cafe being 2588 feet, $10\frac{1}{4}$ inches will fubtend an angle of one minute and 8 feconds, and the angle of incidence of the vifual ray being 32 degrees (becaufe the angle of the glafs planes was 64) it follows from the known laws of refraction, that as the fine of 39° is to that of 31°, 59′, 26″, differing from 32° by 34″ the half of 1′, 8″; fo is the fine of any other incidence, to the fine of its angle of refraction; and fo is radius, or 1000000, to 999736; which, therefore, is the proportion between the fine of incidence *in vacuo* and the fine of refraction from thence into common air.

14 Refractive power of the air determined.

It appears, by thefe experiments, that the refractive power of the air is proportionable to its denfity. And fince the denfity of the atmofphere is as its weight directly, and its heat inverfely, the ratio of its denfity, at any given time, may be had by comparing the heights of the barometer and thermometer; and thence he concludes that this will alfo be the ratio of the refraction of the air. But Dr Smith obferves, that, before we can depend upon the accuracy of this conclufion, we ought to examine whether heat and cold alone may not alter the refractive power of air, while its denfity continues the fame. This, he fays, may

may be tried, by heating the condensed or rarified air, shut up in the prism, just before it is fixed to the telescope, and by observing whether the hair in its focus will continue to cover the same mark all the while that the air is cooling.

The French academicians, being informed of the result of the above-mentioned experiment, employed M. Delisle the younger to repeat their former experiment with more care; and he presently found, that their operators had never made any vacuum at all, there being chinks in their instrument, through which the air had insinuated itself. He therefore annexed a gage to his instrument, by which means he was sure of his vacuum; and then the result of the experiment was the same with that in England. The refraction was always in proportion to the density of the air, excepting when the mercury was very low, and consequently the air very rare; in which case the whole quantity being very small, he could not perceive much difference in them. Comparing, however, the refractive power of the atmosphere, observed at Paris, with the result of his experiment, he found, that the best vacuum he could make was far short of that of the etherial regions above the atmosphere.

Dr Hooke first suggested the thought of making allowance for the effect of the refraction of light, in passing from the higher and rarer, to the lower and denser regions of the atmosphere, in the computed height of mountains. To this he ascribes the different opinions of authors concerning the height of several very high hills. He could not account for the appearance of the Pike of Tenerif, and several very high mountains, at so great a distance as that at which they are actually seen, but upon the supposition of the curvature of the visual ray, that is made by its passing obliquely through a medium of such different density, from the top of them to the eye, very far distant in the horizon. All calculations of the height of mountains that are made upon the supposition that the rays of light come from the tops of them, to our eyes, in straight lines, must, he says, be very erroneous.

Dr Hooke gives a very good account of the twinkling of the stars; ascribing it to the irregular and unequal refraction of the rays of light, which is also the reason why the limbs of the sun, moon, and planets appear to wave or dance. And that there is such an unequal distribution of the parts of the atmosphere, he says, is manifest from the different degrees of heat and cold in the air. This, he says, will be evident by looking upon distant objects, over a piece of hot glass, which cannot be supposed to throw out any kind of exhalation from itself, as well as through ascending steams of water.

15 Colours discovered to arise from refraction.

About this time Grimaldi first observed that the coloured image of the sun refracted through a prism is always oblong, and that colours proceed from refraction.—The way in which first he discovered this was by Vitellio's experiment above-mentioned, in which a piece of white paper placed at the bottom of a glass vessel filled with water, and exposed to the light of the sun, appears coloured. However, he observed, that in case the two surfaces of the refracting medium were exactly parallel to each other, no colours were produced. But of the true cause of those colours, viz. the different refrangibility of the rays of light, he had not the least suspicion. This discovery was reserved for Sir Isaac Newton, and which occurred to him in the year 1666. At that time he was busied in grinding optic glasses, and procured a triangular glass prism to satisfy himself concerning the phenomena of colours. While he amused himself with this, the oblong figure of the coloured spectrum first struck him. He was surprised at the great disproportion betwixt its length and breadth; the former being about five times the measure of the latter. He could hardly think that any difference in the thickness of the glass, or in the composition of it, could have such an influence on the light. However, without concluding any thing *à priori*, he proceeded to examine the effects of these circumstances, and particularly tried what would be the consequence of transmitting the light through parts of the glass that were of different thicknesses, or through holes in the window-shutter of different sizes; or by setting the prism on the outside of the shutter, that the light might pass through it, and be refracted before it was terminated by the hole.

16 Different refrangibility of the rays of light discovered by Sir Isaac Newton.

He then suspected that these colours might arise from the light being dilated by some unevenness in the glass, or some other accidental irregularity; and to try this, he took another prism, like the former, and placed it in such a manner, as that the light, passing through them both, might be refracted contrary ways, and so to be returned by the latter into the same course from which he had been diverted by the former. In this manner he thought that the regular effects of the first prism would be destroyed by the second; but that the irregular ones would be augmented by the multiplicity of refractions. The event was, that the light, which by the first prism was diffused into an oblong form, was by the second reduced into a circular one, with as much regularity as if it had not passed through either of them.

At last, after various experiments and conjectures, he hit upon what he calls the *experimentum crucis*, and which completed this great discovery. He took two boards, and placed one of them close behind the prism at the window, so that the light might pass through a small hole made in it for the purpose, and fall on the other board, which he placed at the distance of about 12 feet; having first made a small hole in it also, for some of that incident light to pass through. He then placed another prism behind the second board, so that the light which was transmitted through both the boards might pass through that also, and be again refracted before it arrived at the wall. This being done, he took the first prism in his hand, and turned it about its axis, so much as to make the several parts of the image, cast on the second board, successively to pass through the hole in it, that he might observe to what places on the wall the second prism would refract them; and he saw, by the change of those places, that the light tending to that end of the image towards which the refraction of the first prism was made, did, in the second prism, suffer a refraction considerably greater than the light which tended to the other end. This true cause, therefore, of the length of that image was discovered to be no other, than that light is not similar, or homogeneal; but that it

it conſiſts of rays, ſome of which are more refrangible than others: ſo that, without any difference in their incidence on the ſame medium, ſome of them ſhall be more refracted than others; and therefore, that, according to their particular degrees of refrangibility, they will be tranſmitted through the priſm to different parts of the oppoſite wall.

Since it appears from theſe experiments that different rays of light have different degrees of refrangibility, it neceſſarily follows, that the rules laid down by preceding philoſophers concerning the refractive power of water, glaſs, &c. muſt be limited to the middle kind of rays. Sir Iſaac, however, proves that the ſine of the incidence of every kind of light, conſidered apart, is to its ſine of refraction in a given ratio. This he deduces, both by experiment, and alſo geometrically, from the ſuppoſition that bodies refract the light by acting upon its rays in lines perpendicular to their ſurfaces.

17
Mr Dollond's diſcovery of the method of correcting the faults in refracting teleſcopes.

The moſt important diſcovery with regard to refraction ſince the time of Sir Iſaac Newton is that of Mr Dollond, who found out a method of curing the faults of refracting teleſcopes ariſing from the different refrangibility of the rays, and which had been generally thought impoſſible to be removed.—Notwithſtanding the great diſcovery of Sir Iſaac Newton concerning the different refrangibility of the rays of light, he had no idea but that they were all affected in the ſame proportion by every medium, ſo that the refrangibility of the extreme rays might be determined if that of the mean ones was given. From this it would follow, as Mr Dollond obſerves, that equal and contrary refractions muſt not only deſtroy each other, but that the divergency of the colours from one refraction would likewiſe be corrected by the other, and there could be no poſſibility of producing any ſuch thing as refraction which would not be affected by the different refrangibility of light; or, in other words, that however a ray of light might be refracted backwards and forwards by different mediums, as water, glaſs, &c. provided it was ſo done, that the emergent ray ſhould be parallel to the incident one, it would ever after be white; and conſequently, if it ſhould come out inclined to the incident, it would diverge, and ever after be coloured; and from this it was natural to infer, that all ſpherical object-glaſſes of teleſcopes muſt be equally affected by the different refrangibility of light, in proportion to their apertures, of whatever materials they may be formed.

For this reaſon, Sir Iſaac Newton, and all other philoſophers and opticians, had deſpaired of bringing refracting teleſcopes to any great degree of perfection, without making them of an immoderate and very inconvenient length. They therefore applied themſelves chiefly to the improvement of the reflecting teleſcope; and the buſineſs of refraction was dropped till about the year 1747, when M. Euler, improving upon a hint of Sir Iſaac Newton's, formed a ſcheme of making object-glaſſes of two materials, of different refractive powers; hoping, that by this difference, the refractions would balance one another, and thereby prevent the diſperſion of the rays that is occaſioned by the difference of refrangibility. Theſe object-glaſſes were compoſed of two lenſes of glaſs with water between them. This memoir of M. Euler excited the attention of Mr Dollond. He carefully went over all M. Euler's calculations, ſubſtituting for his hypothetical laws of refraction, thoſe which had been actually aſcertained by the experiments of Newton; and found, that, after this neceſſary ſubſtitution, it followed from M. Euler's own principles, that there could be no union of the foci of all kinds of colours, but in a lens infinitely large.

M. Euler did not pretend to controvert the experiments of Newton: but he ſaid, that they were not contrary to his hypotheſis, but in ſo ſmall a degree as might be neglected; and aſſerted, that, if they were admitted in all their extent, it would be impoſſible to correct the difference of refrangibility occaſioned by the tranſmiſſion of the rays from one medium into another of different denſity; a correction which he thought was very poſſible, ſince he ſuppoſed it to be actually effected in the ſtructure of the eye, which he thought was made to conſiſt of different mediums for that very purpoſe. To this kind of reaſoning Mr Dollond made no reply, but by appealing to the experiments of Newton, and the great circumſpection with which it was known that he conducted all his inquiries.

In this ſtate of the controverſy, the friends of M. Clairaut engaged him to attend to it; and it appeared to him, that, ſince the experiments of Newton cited by Mr Dollond could not be queſtioned, the ſpeculations of M. Euler were more ingenious than uſeful.

The ſame paper of M. Euler was alſo particularly noticed by M. Klingenſtierna of Sweden, who gave a conſiderable degree of attention to the ſubject, and diſcovered, that, from Newton's own principles, the reſult of the 8th experiment of the ſecond book of his Optics could not anſwer his deſcription of it.

He found, he ſays, that when light goes out of air through ſeveral contiguous refracting mediums, as through water and glaſs, and thence goes out again into air, whether the refracting ſurfaces be parallel or inclined to one another, that light, as often as by contrary refractions it is ſo corrected as to emerge in lines parallel to thoſe in which it was incident, continues ever after to be white; but if the emergent rays be inclined to the incident, the whiteneſs of the emerging light will, by degrees, in paſſing on from the place of emergence, become tinged at its edges with colours. This he tried by refracting light with priſms of glaſs, placed within a priſmatic veſſel of water.

By theorems deduced from this experiment he infers, that the refractions of the rays of every ſort, made out of any medium into air, are known by having the refraction of the rays of any one ſort; and alſo that the refraction out of one medium into another is found as often as we have the refractions out of them both into any third medium.

On the contrary, the Swediſh philoſopher obſerves, that, in this experiment, the rays of light, after paſſing through the water and the glaſs, though they come out parallel to the incident rays, will be coloured; but that the ſmaller the glaſs priſm is, the near will the reſult of it approach to Newton's deſcription.

This paper of M. Klingenſtierna, being communicated to Mr Dollond by M. Mallet, made him entertain

tain doubts concerning Newton's report, and determined him to have recourse to experiment.

He therefore cemented together two plates of parallel glafs at their edges, fo as to form a prifmatic veffel, when ftopped at the ends or bafes; and the edge being turned downwards, he placed in it a glafs prifm, with one of its edges upwards, and filled up the vacancy with clear water; fo that the refraction of the prifm was contrived to be contrary to that of the water, in order that a ray of light, tranfmitted through both thefe refracting mediums, might be affected by the difference only between the two refractions. As he found the water to refract more or lefs than the glafs prifm, he diminifhed or increafed the angle between the glafs plates, till he found the two contrary refractions to be equal; which he difcovered by viewing an object thro' this double prifm. For when it appeared neither raifed or depreffed, he was fatisfied that the refractions were equal, and that the emergent rays were parallel to the incident.

Now, according to the prevailing opinion, he obferves, that the object fhould have appeared thro' this double prifm in its natural colour; for if the difference of refrangibility had been in all refpects equal in the two equal refractions, they would have rectified each other. But this experiment fully proved the fallacy of the received opinion, by fhewing the divergency of the light by the glafs prifm, to be almoft double of that by the water; for the image of the object, though not at all refracted, was yet as much infected with prifmatic colours, as if it had been feen thro' a glafs wedge only, whofe refracting angle was near 30 degrees.

This experiment is the very fame with that of Sir Ifaac Newton's above-mentioned, notwithftanding the refult was fo remarkably different: but Mr Dollond affures us, that he ufed all poffible precaution and care in his procefs; and he kept his apparatus by him, that he might evince the truth of what he wrote, whenever he fhould be properly required to do it.

He plainly faw, however, that if the refracting angle of the water veffel could have admitted of a fufficient increafe, the divergency of the coloured rays would have been greatly diminifhed, or entirely rectified; and that there would have been a very great refraction without colour, as he had already produced a great difcolouring without refraction: but the inconveniency of fo large an angle, as that of the prifmatic veffel muft have been, to bring the light to an equal divergency with that of the glafs prifm whofe angle was about 60 degrees, made it neceffary to try fome experiments of the fame kind with fmaller angles.

Accordingly, he got a wedge of plate glafs, the angle of which was only nine degrees; and ufing it in the fame circumftances, he increafed the angle of the water wedge, in which it was placed, till the divergency of the light by the water was equal to that by the glafs; that is, till the image of the object, though confiderably refracted by the excefs of the refraction of the water, appeared neverthelefs quite free from any colours proceeding from the different refrangibility of the light; and, as near as he could then meafure, the refraction by the water was about $\frac{3}{4}$ of that by the glafs. He acknowledges, indeed, that he was not very exact in taking the meafures, becaufe his bufinefs was not at that time to determine the exact proportions, fo much as to fhew that the divergency of the colours, by different fubftances, was by no means in proportion to the refractions, and that there was a poffibility of refraction without any divergency of the light at all.

As thefe experiments clearly proved, that different fubftances made the light to diverge very differently in proportion to their general refractive power, Mr Dollond began to fufpect that fuch variety might poffibly be found in different kinds of glafs, efpecially as experience had already fhewn that fome of the kinds made much better object-glaffes in the ufual way than others; and as no fatisfactory caufe had been affigned for fuch difference, he thought there was great reafon to prefume that it might be owing to the different divergency of the light in the fame refractions.

His next bufinefs, therefore, was to grind wedges of different kinds of glafs, and apply them together; fo that the refractions might be made in contrary directions, in order to difcover, as in the above-mentioned experiments, whether the refraction and the divergency of the colours would vanifh together. But a confiderable time elapfed before he could fet about that work: for tho' he was determined to try it at his leifure, for fatisfying his own curiofity, he did not expect to meet with a difference fufficient to give room for any great improvement of telefcopes, fo that it was not till the latter end of the year 1757 that he undertook it; but his firft trials convinced him that the bufinefs deferved his utmoft attention and application.

He difcovered a difference far beyond his hopes in the refractive qualities of different kinds of glafs, with refpect to the divergency of colours. The yellow or ftraw-coloured foreign fort, commonly called *Venice glafs*, and the *Englifh crown glafs*, proved to be very nearly alike in that refpect; though, in general, the crown glafs feemed to make the light diverge the lefs of the two. The common Englifh plate-glafs made the light diverge more; and the white cryftal, or Englifh flint-glafs, moft of all.

It was now his bufinefs to examine the particular qualities of every kind of glafs that he could come at, not to amufe himfelf with conjectures about the caufe of this difference, but to fix upon two forts in which it fhould be the greateft; and he foon found thefe to be the crown glafs, and the white flint glafs. He therefore ground one wedge of white flint, of about 25 degrees; and another of crown glafs, of about 29 degrees; which refracted very nearly alike, but their power of making the colours diverge was very different. He then ground feveral others of crown glafs to different angles, till he got one which was equal, with refpect to the divergency of the light, to that in the white flint-glafs: for when they were put together, fo as to refract in contrary directions, the refracted light was entirely free from colours. Then meafuring the refraction of each wedge with thefe different angles, he found that of the white glafs to be to that of the crown glafs, nearly as two to three: and this proportion held very nearly in all fmall angles; fo that any two wedges made in this proportion, and applied

plied together, so as to refract in a contrary direction, would refract the light without any dispersion of the rays.

In a letter to M. Klingenstierna, quoted by M. Clairaut, Mr Dollond says, that the sine of incidence in crown glass is to that of its general refraction as 1 to 1.53, and in flint glass as 1 to 1.583.

To apply this knowledge to practice, Mr Dollond went to work upon the object-glasses of telescopes; not doubting but that, upon the same principles on which a refracted colourless ray was produced by prisms, it might be done by lenses also, made of similar materials. And he succeeded, by considering, that, in order to make two spherical glasses that should refract the light in contrary directions, the one must be concave and the other convex; and as the rays are to converge to a real focus, the excess of refraction must evidently be in the convex lens. Also, as the convex glass is to refract the most, it appeared from his experiments, that it must be made of crown glass, and the concave of white flint glass. Farther, as the refractions of spherical glasses are in an inverse ratio of their focal distances, it follows, that the focal distances of the two glasses shall be inversely as the ratios of the refractions of the wedges; for being thus proportioned, every ray of light that passes thro' this combined glass, at whatever distance it may pass from its axis, will constantly be refracted, by the difference between two contrary refractions, in the proportion required; and therefore the different refrangibility of the light will be entirely removed.

Notwithstanding our author had these clear grounds in theory and experiment to go upon, he found that he had many difficulties to struggle with when he came to reduce them into actual practice; but with great patience and address, he at length got into a ready method of making telescopes upon these new principles.

His principal difficulties arose from the following circumstances. In the first place, the focal distances, as well as the particular surfaces, must be very nicely proportioned to the densities or refracting powers of the glasses, which are very apt to vary in the same sort of glass made at different times. Secondly, The centres of the two glasses must be placed truly in the common axis of the telescope, otherwise the desired effect will be in a great measure destroyed. Add to these, that there are four surfaces to be wrought perfectly spherical; and any person, he says, but moderately practised in optical operations, will allow, that there must be the greatest accuracy throughout the whole work. At length, however, after numerous trials, and a resolute perseverance, he was able to construct refracting telescopes, with such apertures and magnifying powers, under limited lengths, as, in the opinion of the best judges, far exceeded any thing that had been produced before, representing objects with great distinctness, and in their true colours.

It was objected to Mr Dollond's discovery, that the small dispersion of the rays in crown glass is only apparent, owing to the opacity of that kind of glass which does not transmit the fainter coloured rays in a sufficient quantity; but this objection is particularly considered, and answered by M. Beguelin.

As Mr Dollond did not explain the methods which he took in the choice of different spheres proper to destroy the effect of the different refrangibility of the rays of light, and gave no hint that he himself had any rule to direct himself in it; and as the calculation of the dispersion of the rays, in so complicated an affair, is very delicate; M. Clairaut, who had given a good deal of attention to this subject, from the beginning of the controversy, endeavoured to make out a complete theory of it.

Without some assistance of this kind, it is impossible, says this author, to construct telescopes of equal goodness with those of Mr Dollond, except by a servile imitation of his; which, however, on many accounts, would be very unlikely to answer. Besides, Mr Dollond only gave his proportions in general, and pretty near the truth; whereas the greatest possible precision is necessary. Also the best of Mr Dollond's telescopes were far short of the Newtonian ones (A); whereas it might be expected that they should exceed them, if the foci of all the coloured rays could be as perfectly united after refraction thro' glass, as after reflexion from a mirror; since there is more light lost in the latter case than in the former.

With a view, therefore, to assist the artist, he endeavoured to ascertain the refractive power of different kinds of glass, and also their property of separating the rays of light, by the following exact methods. He made use of two prisms placed close to one another, as Mr Dollond had done: but, instead of looking thro' them, he placed them in a darkened room; and when the image of the sun, transmitted thro' them, was perfectly white, he concluded that the different refrangibility of the rays was corrected.

In order to ascertain with more ease the true angles that prisms ought to have to destroy the effect of the difference of refrangibility, he constructed one which had one of its surfaces cylindrical, with several degrees of amplitude. By this means, without changing his prisms, he had the choice of an infinity of angles; among which, by examining the point of the curve surface, which, receiving the solar ray, gave a white image, he could easily find the true one.

He also ascertained the proportion in which different kinds of glass separated the rays of light, by measuring, with proper precautions, the oblong image of the sun, made by transmitting a beam of light thro' them. In making these experiments, he hit upon an easy method of convincing any person of the greater refractive power of English flint-glass above the common French glass, both with respect to the mean refraction, and the different refrangibility of the colours; for having taken two prisms, of these two kinds of glass, but equal in all other respects, and placed them so that they received, at the same time, two rays of the sun, with the same degree of incidence, he saw, that, of the two images, that which was produced by the English flint-glass was a little higher upon the wall than the other, and longer by more than one half.

M. Clairaut was assisted in these experiments by M. De Tournieres, and the results agreed with Mr Dollond's

(A) This assertion of M. Clairaut might be true at the time that it was made, but it is by no means so at present.

lond's in general; but whereas Mr Dollond had made the difperfion of the rays in glafs and in water to be as five to four (acknowledging, however, that he did not pretend to do it with exactnefs) thefe gentlemen, who took more pains, and ufed more precautions, found it to be as three to two. For the theorems and problems deduced by M. Clairaut from thefe new principles of optics, with a view to the perfection of telefcopes, we muft refer the reader to *Mem. Acad. Par.* 1756, 1757.

The labours of M. Clairaut were fucceeded by thofe of M. D'Alembert, which feem to have given the makers of thefe achromatic telefcopes all the aid that calculations can afford them. This excellent mathematician has likewife propofed a variety of new conftructions of thefe telefcopes, the advantages and difadvantages of which he diftinctly notes; at the fame time that he points out feveral methods of correcting the errors to which they are liable: as by placing the object-glaffes, in fome cafes, at a fmall diftance from one another, and fometimes by ufing eye-glaffes of different refractive powers; which is an expedient that feems not to have occurred to any perfon before him. He even fhews, that telefcopes may be made to advantage, confifting of only one object-glafs, and an eye-glafs of a different refractive power. Some of his conftructions have two or more eye-glaffes of different kinds of glafs. This fubject he confidered at large in one of the volumes of his *Opufcules Mathematiques*. We have alfo three memoirs of M. D'Alembert upon this fubject, among thofe of the French Academy; one in the year 1764, another in 1765, and a third in 1767.

At the conclufion of his fecond memoir he fays, that he does not doubt, but, by the different methods he propofes, achromatic telefcopes may be made to far greater degrees of perfection than any that have been feen hitherto, and even fuch as is hardly credible: And tho' the crown glafs, by its greenifh colour, may abforb fome part of the red or violet rays, which, however, is not found to be the cafe in fact; that objection cannot be made to the common French glafs, which is white, and which on this account he thinks muft be preferable to the Englifh crown glafs.

Nothwithftanding Meffrs Clairaut and D'Alembert feemed to have exhaufted the bufinefs of calculation on the fubject of Mr Dollond's telefcopes, no ufe could be made of their labours by foreign artifts. For ftill the telefcopes made in England, according to no exact rule, as foreigners fuppofed, were greatly fuperior to any that could be made elfe where, though under the immediate direction of thofe able calculators. For this M. Beguelin affigned feveral reafons. Among others, he thought that their geometrical theorems were too general, and their calculations too complicated, for the ufe of workmen. He alfo thought, that in confequence of neglecting fmall quantities, which thefe calculators profeffedly did, in order to make their algebraical expreffions more commodious, their conclufions were not fufficiently exact. But what he thought to be of the moft confequence, was the want of an exact method of meafuring the refractive and difperfing powers of the different kinds of glafs; and for want of this, the greateft precifion in calculation was altogether ufelefs.

Thefe confiderations induced this gentleman to take another view of this fubject; but ftill he could not reconcile the actual effect of Mr Dolland's telefcopes with his own conclufions: fo that he imagined, either that he had not the true refraction and difperfion of the two kinds of glafs given him; or elfe, that the aberration which ftill remained after his calculations, muft have been deftroyed by fome irregularity in the furfaces of the lenfes. He finds feveral errors in the calculations both of M. D'Alembert and Clairaut, and concludes with expreffing his defign to purfue this fubject much farther.

M. Euler, who firft gave occafion to this inquiry, which terminated fo happily for the advancement of fcience, being perfuaded both by his reafoning and calculations, that Mr Dollond had difcovered no new principle in optics, and yet not being able to controvert Mr Short's teftimony in favour of the goodnefs of his telefcopes, concluded that this extraordinary effect was owing, in part, to the crown glafs not tranfmitting all the red light, which would otherwife have come to a different focus, and have diftorted the image; but principally to his happening to hit on a juft curvature of his glafs, which he did not doubt would have produced the fame effect if his lenfes had all been made of the fame kind of glafs. In another place he imagines that the goodnefs of Mr Dollond's telefcope might be owing to the eye-glafs. If my theory, fays he, be true, this difagreeable confequence follows, that Mr Dollond's object-glaffes cannot be exempt from the difperfion of colours: yet a regard to fo refpectable a teftimony embarraffes me extremely, it being as difficult to queftion fuch exprefs authority, as to abandon a theory which appears me perfectly well founded, and to embrace an opinion, which is as contrary to all the eftablifhed laws of nature, as it is ftrange and feemingly abfurd. He even appeals to experiments made in a darkened room; in which, he fays, he is confident that Mr Dollond's object-glaffes would appear to have the fame defects that others are fubject to.

No doubting, however, but that Mr Dollond, either by chance, or otherwife, had made fome confiderable improvement in the conftruction of telefcopes, by the combination of glaffes; he abandoned his former project, in which he had recourfe to different mediums, and confined his attention to the correction of the errors which arife from the curvature of lenfes. But while he was proceeding, as he imagined, upon the true principles of optics, of which, however, he made but little ufe, he could not help expreffing his furprife that Mr Dollond fhould have been led to fo important a difcovery by reafoning in a manner quite contrary to the nature of things. At length, however, Mr Euler was convinced of the reality and importance of Mr Dollond's difcoveries; and very frankly acknowledges, that he fhould, perhaps, never have been brought to affent to it, had not his friend M. Clairaut affured him that the experiments of the Englifh optician might be depended upon. However, the experiments of M. Zeiher of Peterfburgh gave him the moft complete fatisfaction with refpect to this new law of refraction.

This gentleman demonftrated, that it is the lead in the compofition of glafs that gives it this remarkable property,

property, that while the refraction of the mean rays is nearly the ſame, that of the extremes differs conſiderably. And, by increaſing the quantity of lead in the mixture, he produced a kind of glaſs, which occaſioned a much greater ſeparation of the extreme rays than the flint-glaſs which Mr Dollond had made uſe of. By this evidence M. Euler owns that he was compelled to renounce the principle which, before this time, had been conſidered as inconteſtible, *viz.* that the diſperſion of the extreme rays depends upon the refraction of the mean; and that the former varies with the quality of the glaſs, while the latter is not affected by it.

From theſe new principles M. Euler deduces theorems concerning the combination of the lenſes, and, in a manner ſimilar to M. Clairaut and D'Alembert, points out methods of conſtructing achromatic teleſcopes.

18 Different compoſitions of glaſs for the purpoſe of correcting the faults of refracting teleſcopes.

While he was employed upon this ſubject, he informs us, that he received a letter from M. Zeiher, dated Peterſburgh 30th of January 1764, in which he gives him a particular account of the ſucceſs of his experiments on the compoſition of glaſs; and that, having mixed minium and ſand in different proportions, the reſult of the mean refraction and the diſperſion of the rays varied according to the following table.

Proportion of minium to flint.	Mean refraction from air into glaſs.	Diſperſion of the rays in compariſon of crown-glaſs.
I. — 3 : 1	2028 : 1000	4800 : 1000
II. — 2 : 1	1830 : 1000	3550 : 1080
III. — 1 : 1	1787 : 1000	3259 : 1000
IV. — $\frac{3}{4}$: 1	1732 : 1000	2207 : 1000
V. — $\frac{1}{2}$: 1	1724 : 1000	1800 : 1000
VI. — $\frac{1}{4}$: 1	1664 : 1000	1354 : 1000

By this table it is evident, that a greater quantity of lead not only occaſions a greater diſperſion of the rays, but alſo conſiderably increaſes the mean refraction. The firſt of theſe kinds of glaſs, which contains three times as much minium as flint, will appear very extraordinary; ſince, hitherto, no tranſparent ſubſtance has been known, whoſe refractive power exceded the ratio of two to one, and that the diſperſion occaſioned by this glaſs is almoſt five times as great at that of crown glaſs, which could not be believed by thoſe who entertained any doubt concerning the ſame property in flint glaſs, the effect of which is three times as great as crown glaſs. One may obſerve, however, in theſe kinds of glaſs, ſomething of a proportion between the mean refraction and the diſperſion of rays, which may enable us to reconcile theſe ſurpriſing effects with other principles already known,

Here, however, M. Euler announces to us another diſcovery of the ſame M. Zeiher, no leſs ſurpriſing than the former, and which diſconcerted all his ſchemes for reconciling the above-mentioned phenomena. As the ſix kinds of glaſs mentioned in the above table were compoſed of nothing but minium and flint, M. Zeiher happened to think of mixing alkaline ſalts with them, in order to give the glaſs a conſiſtence more proper for dioptric uſes; when he was much ſurpriſed to find this mixture greatly diminiſhed the mean refraction, almoſt without making any change in the diſperſion. After many trials, he at length obtained a kind of glaſs greatly ſuperior to the flint-glaſs of Mr Dollond, with reſpect to the conſtruction of teleſcopes; ſince it occaſioned three times as great a diſperſion of the rays as the common glaſs, at the ſame time that the mean refraction was only as 1.61 to 1.

M. Euler alſo gives particular inſtructions how to find both the mean and extreme refractive power of different kinds of glaſs; and particularly adviſes to make uſe of priſms with very large refracting angles, not leſs than 70°.

Notwithſtanding it evidently appeared, we may ſay, to almoſt all philoſophers, that Mr Dollond had made a real diſcovery of ſomething not comprehended in the optical principles of Sir Iſaac Newton, it did not appear ſo to Mr Murdoch. Upon this occaſion, he interpoſed in the defence, as he imagined, of Sir Iſaac Newton; maintaining, that Mr Dollond's poſitions, which, he ſays, he knows not by what miſhap have been deemed paradoxes in Sir Iſaac's theory of light, are really the neceſſary conſequences of it. He alſo endeavours to ſhew that Sir Iſaac might not be miſtaken in his account of the experiment above-mentioned. But, admitting all that he advances in this part of his defence, Newton muſt have made uſe of a priſm with a much ſmaller refracting angle than, from his own account of his experiments, we have any reaſon to believe that he ever did make uſe of.

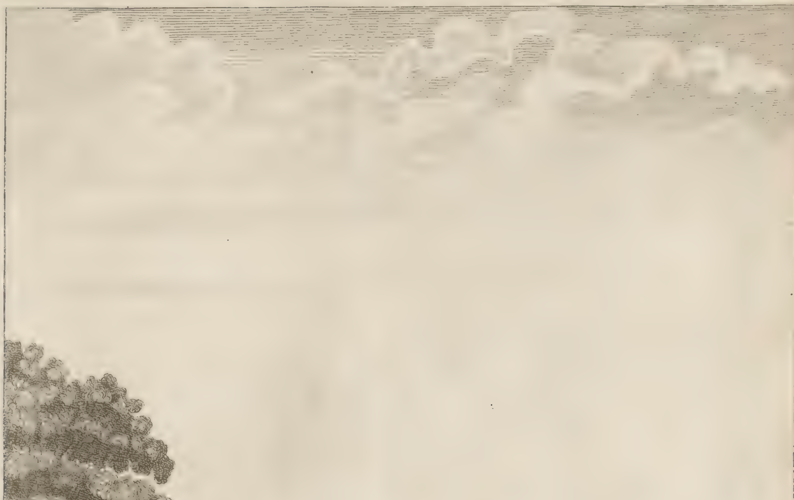
The fact probably was, that Sir Iſaac deceived himſelf in this caſe, by attending to what he imagined to be the clear conſequence of his other experiments; and though the light he ſaw was certainly tinged with colours, and he muſt have ſeen it to be ſo, yet he might imagine that this circumſtance aroſe from ſome imperfection in his priſms, or in the diſpoſition of them, which he did not think it worth his while to examine. It is alſo obſervable, that Sir Iſaac is not ſo particular in his deſcription of his priſms, and other parts of his apparatus, in his account of this experiment, as he generally is in other caſes; and therefore, probably, wrote his account of it from his memory only. In reality, it is no reflection upon Sir Iſaac Newton, who did ſo much, to ſay that he was miſtaken in this particular caſe, and that he did not make the diſcovery that Mr Dollond did; though it be great praiſe to Mr Dollond, and all thoſe perſons who contributed to this diſcovery, that they ventured to call in queſtion the authority of ſo great a man.

19 Of the refraction of the atmoſphere.

We ſhall conclude the hiſtory of the diſcoveries concerning refraction, with ſome account of the refractions of the atmoſphere.—Tables of this have been calculated by Mr Lambert with a view to correct the inaccuracies of geometrical obſervations of the altitudes of mountains. The obſervations of Mr Lambert, however, go upon the ſuppoſition that the refractive power of the atmoſphere is invariable: But this is by no means the caſe; and therefore his rules muſt be conſidered as true for the mean ſtate of the air only.

A moſt remarkable variety in the refractive power of the atmoſphere was obſerved by Dr Nettleton, near Halifax in Yorkſhire, which demonſtrates how little we can depend upon the calculated heights of mountains, when the obſervations are made with an inſtrument, and the refractive power of the air is to be allowed

Bramin's OBSERVATORY. Plate CCV.



A Bell Sculp.

lowed for. Being deſirous to learn, by obſervation, how far the mercury would deſcend in the barometer at any given elevation, (for which there is the beſt opportunity in that hilly country), he propoſed to take the height of ſome of their higheſt hills; but when he attempted it, he found his obſervation ſo much diſturbed by refraction, that he could come to no certainty. Having meaſured one hill of a conſiderable height, in a clear day, and obſerved the mercury at the bottom and at the top, he found, according to that eſtimation, that about 90 feet, or more, were required to make the mercury fall $\frac{1}{10}$ of an inch; but afterwards, repeating the experiment on a cloudy day, when the air was rather groſs and hazy, he found the ſmall angles ſo much increaſed by refraction as to make the hill much higher than before. He afterwards frequently made obſervations at his own houſe, by pointing a quadrant to the tops of ſome neighbouring hills, and obſerved that they would appear higher in the morning before ſun-riſe, and alſo late in the evening, than at noon in a clear day, by ſeveral minutes. In one caſe the elevations of the ſame hill differed more than 30 minutes. From this he infers, that obſervations made on very high hills, eſpecially when viewed at a diſtance, and under ſmall angles, as they generally are, are probably uncertain, and not much to be depended upon.

M. Euler conſidered with great accuracy the refractive power of the atmoſphere, as affected by different degrees of heat and elaſticity, in which he ſhews, that its refractive power, to a conſiderable diſtance from the zenith, is ſufficiently near the proportion of the tangent of that diſtance, and that the law of refraction follows the direct ratio of the height of the barometer, and the inverſe ratio of the difference marked by the thermometer; but when ſtars are in the horizon, the changes are in a ratio ſomewhat greater than this, more eſpecially on account of the variation in the heat.

20 Mr Michell's opinion concerning the twinkling of the ſtars.

The cauſe of the twinkling of the ſtars is now generally acknowledged to be the unequal refraction of light, in conſequence of inequalities and undulations in the atmoſphere.

Mr Michell ſuppoſes that the arrival of fewer or more rays at one time, eſpecially from the ſmaller or the more remote fixed ſtars, may make ſuch an unequal impreſſion upon the eye, as may, at leaſt, have ſome ſhare in producing this effect; ſince it may be ſuppoſed, that even a ſingle particle of light is ſufficient to make a ſenſible impreſſion upon the organs of ſight; ſo that very few particles arriving at the eye in a ſecond of time, perhaps no more than three or four, may be ſufficient to make an object conſtantly viſible. For though the impreſſion may be conſidered as momentary, yet the perception occaſioned by it is of ſome duration. Hence, he ſays, it is not improbable that the number of the particles of light which enter the eye in a ſecond of time, even from Sirius himſelf, (the light of which does not exceed that of the ſmalleſt viſible fixed ſtar, in a greater proportion than that of about 1000 to 1), may not exceed 3000 or 4000, and from ſtars of the ſecond magnitude they may, therefore, probably not exceed 100. Now the apparent increaſe and diminution of the light which we obſerve in the twinkling of the ſtars, ſeems to be repeated at not very unequal intervals, perhaps about four or five times in a ſecond. He therefore thought it reaſonable to ſuppoſe, that the inequalities which will naturally ariſe from the chance of the rays coming ſometimes a little denſer, and ſometimes a little rarer, in ſo ſmall a number of them, as muſt fall upon the eye in the fourth or fifth part of a ſecond, may be ſufficient to account for this appearance. An addition of two or three particles of light, or perhaps a ſingle one, upon 20, eſpecially if there ſhould be an equal deficiency out of the next 20, would, he ſuppoſed, be very ſenſible, as he thought was probable from the very great difference in the appearance of ſtars, the light of which does not differ ſo much as is commonly imagined. The light of the middlemoſt ſtar in the tail of the great bear does not, he thinks, exceed the light of the very ſmall ſtar that is next to it in a greater proportion than that of about 16 or 20 to 1; and M. Bouger found, that a difference in the light of objects of one part in 66 was ſufficiently diſtinguiſhable.

It will perhaps, he ſays, be objected, that the rays coming from Sirius are too numerous to admit of a ſufficient inequality ariſing from the common effect of chance, ſo frequently as would be neceſſary to produce this effect, whatever might happen with reſpect to the ſmaller ſtars; but he obſerves, that, till we know what inequality is neceſſary to produce this effect, we can only gueſs at it one way or the other.

Since theſe obſervations were publiſhed, Mr Michell has entertained ſome ſuſpicion that the unequal denſity of light does not contribute to this effect in ſo great a degree as he had imagined, eſpecially in conſequence of obſerving that even Venus does ſometimes twinkle. This he once obſerved her to do remarkably when ſhe was about 6 degrees high, though Jupiter, which was then about 16 degrees high, and was ſenſibly leſs luminous, did not twinkle at all. If, notwithſtanding the great number of rays which, no doubt, come to the eye from ſuch a ſurface as this planet preſents, its appearance be liable to be affected in this manner, it muſt be owing to ſuch undulations in the atmoſphere, as will probably render the effect of every other cauſe altogether inſenſible. The conjecture, however, has ſo much probability in it, that it well deſerved to be recited.

21 Mr Muſchenbroek's opinion.

M. Muſchenbroek ſuſpects, that the twinkling of the ſtars ariſes from ſome affection of the eye, as well as the ſtate of the atmoſphere. For he ſays, that in Holland, when the weather is froſty, and the ſky very clear, the ſtars twinkle moſt manifeſtly to the naked eye, though not in teleſcopes; and ſince he does not ſuppoſe that there is any great exhalation, or dancing of the vapour at that time, he queſtions whether the vivacity of the light affecting the eye may not be concerned in the phenomenon.

But this philoſopher might very eaſily have ſatisfied himſelf with reſpect to this hypotheſis, by looking at the ſtars near the zenith, when the light traverſes but a ſmall part of the atmoſphere, and therefore might be expected to affect the eye the moſt ſenſibly. For he would not have perceived them to twinkle near ſo much, as they do nearer the horizon, when much more of their light is intercepted by the atmoſphere.

Some aſtronomers have lately endeavoured to explain the twinkling of the fixed ſtars by the extreme minuteneſs of their apparent diameter; ſo that

 they

they ſuppoſe the ſight of them is intercepted by every mote that floats in the air. But Mr Michell obſerves, that no object can hide a ſtar from us that is not large enough to exceed the apparent diameter of the ſtar, by the diameter of the pupil of the eye; ſo that if a ſtar was a mathematical point, the interpoſing object muſt ſtill be equal in ſize to the pupil of the eye: nay, it muſt be large enough to hide the ſtar from both eyes at the ſame time.

Beſides a variation in the quantity of light, a momentary change of colour has likewiſe been obſerved in ſome of the fixed ſtars. Mr Melville ſays, that when one looks ſtedfaſtly at Sirius, or any bright ſtar not much elevated above the horizon, its colour ſeems not to be conſtantly white, but appears tinctured, at every twinkling, with red and blue. This obſervation Mr Melville puts among his queries, with reſpect to which he could not entirely ſatisfy himſelf; and he obſerves, that the ſeparation of the colours by the refractive power of the atmoſphere is, probably, too ſmall to be perceived. But the ſuppoſition of Mr Michell above-mentioned will pretty well account for this circumſtance, though it may be thought inadequate to the former caſe. For the red and blue rays being much fewer than thoſe of the intermediate colours, and therefore much more liable to inequalities, from the common effect of chance, a ſmall exceſs or defect in either of them will make a very ſenſible difference in the colour of the ſtars.

§ 3. *Diſcoveries concerning the Reflection of Light.*

22 Account of the diſcoveries of the ancients.

However much the ancients might have been miſtaken with regard to the nature of light, we find that they were acquainted with two very important obſervations concerning it; viz. that light is propagated in right lines, and that the angle of incidence is equal to the angle of reflection. Who it was that firſt made theſe important obſervations is not known. But indeed, important as they are, and the foundation of a great part of even the preſent ſyſtem of optics, it is poſſible that, if he were known, he might not be allowed to have any ſhare of merit, at leaſt for the *former* of them; the fact is ſo very obvious, and ſo eaſily aſcertained. As to the latter, that *the angle of incidence is equal to the angle of reflection* it was probably firſt diſcovered by obſerving a ray of the ſun reflected from the ſurface of water, or ſome other poliſhed body; or from obſerving the images of objects reflected by ſuch ſurfaces. If philoſophers attended to this phenomenon at all, they could not but take notice, that, if the ray fell nearly perpendicular upon ſuch a ſurface, it was reflected near the perpendicular; and if it fell obliquely, it was reflected obliquely: and if they thought of applying any kind of meaſures to theſe angles, however coarſe and imperfect, they could not but ſee that there was ſufficient reaſon to aſſert their equality. At the ſame time they could not but know that the incident and reflected rays were both in the ſame plane.

Ariſtotle was ſenſible that it is the reflection of light from the atmoſphere which prevents total darkneſs after the ſun ſets, and in places where he doth not ſhine in the day-time. He was alſo of opinion, that rainbows, halos, and mock ſuns, were all occaſioned by the reflection of the ſunbeams in different circumſtances, by which an imperfect image of his body was produced, the colour only being exhibited, and not his proper figure. The image, he ſays, is not ſingle, as in a mirror; for each drop of rain is too ſmall to reflect a viſible image, but the conjunction of all the images is viſible.

23 Euclid's treatiſe of optics.

Without inquiring any farther into the nature of light or viſion, the ancient geometricians contented themſelves with deducing a ſyſtem of optics from the two obſervations mentioned above, viz. the rectilinear progreſs of light, and the equality of the angles of incidence and reflection. The treatiſe of optics which has been aſcribed to Euclid is employed about determining the aparent ſize and figure of objects, from the angle under which they appear, or which the extremities of them ſubtend at the eye, and apparent place of the image of an object reflected from a poliſhed mirror; which he fixes at the place where the reflected ray meets a perpendicular to the mirror drawn through the object. But this work is ſo imperfect, and ſo inaccurately drawn up, that it is not generally thought to be the production of that great geometrician.

24 Of the burning-glaſſes of the ancients.

It appears from a circumſtance in the hiſtory of Socrates, that the effects of burning-glaſſes had alſo been obſerved by the ancients; and it is probable that the Romans had a method of lighting their ſacred fire by means of a concave ſpeculum. It ſeems indeed to have been known pretty early, that there is an increaſe of heat in the place where the rays of light meet, when they are reflected from a concave mirror. The burning power of concave mirrors is taken notice of by Euclid in the ſecond book of the treatiſe abovementioned. If we give but a ſmall degree of credit to what ſome ancient hiſtorians are ſaid to have written concerning the exploits of Archimedes, we ſhall be induced to think that he made great uſe of this principle, in conſtructing ſome very powerful burning-mirrors; but nothing being ſaid of other perſons making uſe of his inventions, the whole account is very doubtful. It is allowed, however, that this eminent geometrician did write a treatiſe on the ſubject of burning-mirrors, though it be not now extant.

B. Porta ſuppoſes that the burning-mirrors of the ancients were of metal, in the form of a ſection of a parabola. It follows from the properties of this curve, that all the rays which fall upon it, parallel to its axis, will meet in the ſame point at the focus. Conſequently, if the vertex of the parabola be cut off, as in fig. 1. it will make a convenient burning-mirror. Plate CCVI
In ſome drawings of this inſtrument fruſtum is ſo ſmall, as to look like a ring. With an inſtrument of this kind, it is thought, that the Romans lighted their ſacred fire. Some have alſo thought that this was the form of the mirror with which Archimedes burnt the Roman fleet; uſing either a lens, to throw the rays parallel, when they had been brought to a focus; or applying a ſmaller parabolic mirror for this purpoſe, as is repreſented fig. 2. But Dechales ſhows, that it is impoſſible to convey any rays in a direction parallel to one another, except thoſe that come from the ſame point in the ſun's diſk.

25 Of ſeeing images in the air.

All this time, however, the nature of reflection was very far from being underſtood. Even lord Bacon, who

who made much greater advances in natural philosophy than his predecessors, and who pointed out the true method of improving it, was so far deceived with regard to the nature of reflection and refraction, that he supposed it possible to see the image reflected from a looking-glass, without seeing the glass itself; and to this purpose he quotes a story of friar Bacon, who is reported to have apparently walked in the air between two steeples, and which was thought to have been effected by reflection from glasses while he walked upon the ground.

The whole business of seeing images in the air may be traced up to Vitellio; and what he said upon the subject seems to have passed from writer to writer, with considerable additions, to the time of lord Bacon. What Vitellio endeavours to shew is, that it is possible, by means of a cylindrical convex speculum, to see the images of objects in the air, out of the speculum, when the objects themselves cannot be seen. But, if his description of the apparatus requisite for this experiment be attended to, it will be seen that the eye was to be directed towards the speculum, which was placed within a room, while both the object and the spectator were without it. But though he recommends this observation to the diligent study of his readers, he has not described it in such a manner as is very intelligible; and, indeed, it is certain, that no such effect can be produced by a convex mirror. If he himself did make any trial with the apparatus that he describes for this purpose, he must have been under some deception with respect to it.

B. Porta says, that this effect may be produced by a plane mirror only; and that an ingenious person may succeed in it: but his more particular description of a method to produce this extraordinary appearance is by a plane mirror and a concave one combined.

Kircher also speaks of the possibility of exhibiting these pendulous images, and supposes that they are reflected from the dense air; and the most perfect and pleasing deception depending upon the images in the air is one of which this writer gives a particular account in his *Ars Magna Lucis et Umbræ*, p. 783. In this case the image is placed at the bottom of a hollow polished cylinder, by which means it appears like a real solid substance, suspended within the mouth of the vessel. In this manner, he says, he once exhibited a representation of the ascension of Christ; when the images were so perfect, that the spectators could not be persuaded, but by attempting to handle them, that they were not real substances.

Among other amusing things that were either invented or improved by Kircher, was the method of throwing the appearance of letters, and other forms of things, into a darkened room from without, by means of a lens and a plane mirror. The figures or letters were written upon the face of the mirror, and inverted; and the focus of the lens was contrived to fall upon the screen or wall that received their images. In this manner, he says, that with the light of the sun he could throw a plain and distinct image 500 feet.

26 Discoveries of Kepler and Gregory.

It was Kepler who first discovered the true reason of the apparent places of objects seen by reflecting mirrors, as it depends upon the angle which the rays of light, issuing from the extreme part of an object, make with one another after such reflections. In plane mirrors these rays are reflected with the same degree of inclination to one another that they had before their incidence; but he shews that this inclination is changed in convex and concave mirrors.

27 Of Mr Boyle.

Mr Boyle made some curious observations concerning the reflecting powers of differently coloured substances. Many learned men, he says, imagined that snow affects the eyes, not by a *borrowed*, but by a *native* light; but having placed a quantity of snow in a room from which all foreign light was excluded, neither he nor any body else was able to perceive it. To try whether white bodies reflect more light than others, he held a sheet of white paper in a sun-beam admitted into a darkened room; and observed that it reflected much more light than a paper of any other colour, a considerable part of the room being enlightened by it. Farther, to shew that white bodies reflect the rays outwards, he adds, that common burning-glasses will not of a long time burn or discolour white paper. When he was a boy, he says, and took great pleasure in making experiments with these glasses, he was much surprised at this remarkable circumstance; and it set him very early upon guessing at the nature of whiteness, especially as he observed that the image of the sun was not so well defined upon white paper as upon black; and as, when he put ink upon the paper, the moisture would be quickly dried up, and the paper, which he could not burn before, would presently take fire. He also found, that, by exposing his hand to the sun, with a thin black glove upon it, it would be suddenly and more considerably heated, than if he held his naked hand to the rays, or put on a glove of thin white leather.

To prove that black is the reverse of white, with respect to its property of reflecting the rays of the sun, he procured a large piece of black marble; and having got it ground into the form of a large spherical concave speculum, he found that the image of the sun reflected from it was far from offending or dazzling his eyes, as it would have done from another speculum; and tho' this was large, he could not in a long time set a piece of wood on fire with it; tho' a far less speculum, of the same form, and of a more reflecting substance, would presently have made it flame.

To satisfy himself still farther with respect to this subject, he took a broad and large tile; and having made one half of its surface white and the other black, he exposed it to the summer sun. And having let it lie there some time, he found, that while the whited part remained cool, the part that was black was grown very hot. For his farther satisfaction, he sometimes left part of the tile of its native red; and, after exposing the whole to the sun, observed that this part grew hotter than the white, but was not so hot as the black part. He also observes, that rooms hung with black are not only darker than they would otherwise be, but warmer too; and he knew several persons, who found great inconvenience from rooms hung with black. As another proof of his hypothesis, he informs, that a virtuoso, of unsuspected credit, acquainting him, that, in a hot climate, he had seen eggs well roasted in a short time, by first blacking the shells, and then exposing them to the sun.

28 Of the infusion of lignum nephriticum.

We have already taken notice of the remarkable property of lignum nephriticum first observed by Kircher.

cher. However, all his obfervations with regard to it fell very fhort of Mr Boyle. He defcribes this lignum nephriticum to be a whitifh kind of wood, that was brought from Mexico, which the natives call *coatl* or *tlapazatli*, and which had been thought to tinge water of a green colour only; but he fays that he found it to communicate all kinds of colours. If, fays he, an infufion of this wood be put into a glafs globe, and expofed to a ftrong light, it will be as colourlefs as pure water; but if it be carried into a place a little fhaded, it will be a moft beautiful green. In a place ftill more fhaded, it will incline to red; and in a very fhady place, or in an opaque veffel, it will be green again.

A cup of this remarkable wood was fent to Kircher by the procurator of his fociety at Mexico, and was prefented by him to the emperor as a great curiofity. It is called *lignum nephriticum*, becaufe the infufion of it was imagined to be of fervice in difeafes of the kidneys and bladder, and the natives of the country where it grows do make ufe of it for that purpofe.

Mr Boyle corrected feveral of the hafty obfervations of Kircher concerning the colours that appear in the infufion of lignum nephriticum, and he diverfified the experiments with it in a very pleafing manner. He firft diftinctly noted the two very different colours which this remarkable tincture exhibits, by tranfmitted and reflected light. If, fays he, it be held directly between the light and the eye, it will appear tinged (excepting the very top of it, where a fky-coloured circle fometimes appears) almoft of a golden colour, except the infufion be too ftrong; in which cafe it will be dark or reddifh, and requires to be diluted with water. But if it be held from the light, fo that the eye be between the light and the phial, it will appear of a deep lovely blue colour; as will alfo the drops, if any lie on the outfide of the glafs.

When a little of this tincture was poured upon a fheet of white paper, and placed in a window where the fun could fhine upon it, he obferved, that if he turned his back upon the fun, the fhadow of his pen, or any fuch flender fubftance, projected upon the liquor, would not be all dark, like other fhadows; but that part of it would be curioufly coloured, the edge of it next the body being almoft of a lively golden colour, and the more remote part blue. Thefe, and other experiments of a fimilar nature, many of his friends, he fays, beheld with wonder; and he remembered an excellent oculift, who accidentally meeting with a phial full of this liquor, and being unacquainted with this remarkable property of it, imagined, after he had viewed it a long time, that fome new and ftrange diftemper had feized his eyes: and Mr Boyle himfelf acknowledges, that the oddnefs of the phenomenon made him very defirous to find out the caufe of it; and his inquiries were not altogether unfuccefsful.

Obferving that this tincture, if it were too deep, was not tinged in fo beautiful a manner, and that the impregnating virtue of the wood did, by being frequently infufed in frefh water, gradually decay, he conjectured that the tincture contained much of the effential falt of the wood; and to try whether the fubtle parts, on which the colour depended, were volatile enough to be diftilled, without diffolving their texture, he applied fome of it to the gentle heat of a lamp-furnace; but he found all that came over was as limpid and colourlefs as rock water, while that which remained behind was of fo deep a blue, that it was only in a very ftrong light that it appeared of any colour.

Sufpecting that the tinging particles abounded with falts, whofe texture, and the colour thence arifing, would probably be altered by acids, he poured into a fmall quantity of it a very little fpirit of vinegar, and found that the blue colour immediately vanifhed, while the golden one remained, on which ever fide it was viewed with refpect to the light.

Upon this he imagined, that as the acid falts of the vinegar had been able to deprive the liquor of its blue colour, a fulphureous falt, which is of a contrary nature, would deftroy their effects; and having placed himfelf betwixt the window and the phial, and let fall into the fame liquor a few drops of oil of tartar *per deliquium*, he found that it was immediately reftored to its former blue colour, and exhibited all the fame phenomena which it had done at the firft.

Having fometimes brought a round long-necked phial, filled with this tincture, into a darkened room, into which a beam of the fun was admitted by a fmall aperture; and holding the phial fometimes near the fun-beams, and fometimes partly in them and partly out of them, changing alfo the pofition of the glafs, and viewing it from feveral parts of the room, it exhibited a much greater variety of colours than it did in an enlightened room. Befides the ufual colours, it was red in fome places, and green in others, and within were intermediate colours produced by the different degrees and odd mixtures of light and fhade.

It was not only in this tincture of lignum nephriticum that Mr Boyle obferved the difference between reflected and tranfmitted light. He obferved it even in gold, tho' no perfon explained the caufe of thefe effects before Sir Ifaac Newton. He took a piece of leaf-gold, and holding it betwixt his eye and the light, obferved that it did not appear of a golden colour, but of a greenifh blue. He alfo obferved the fame change of colour by candle-light; but the experiment did not fucceed with a leaf of filver.

The conftitution of the atmofphere and of the fea, we fhall find, by obfervations made in later periods, to be fimilar to that of this infufion; for the blue rays, and others of a faint colour, do not penetrate fo far into them as the red, and others of a ftronger colour: but what this conftitution is, which is common to them all, deferves to be inquired into. For almoft all other tinctures, and this of lignum nephriticum too, after fome change made in it by Mr Boyle, as well as all other femi-tranfparent coloured fubftances, as glafs, appear of the fame hue in all pofitions of the eye. To increafe or diminifh the quantity makes no difference, but to make the colour deeper or more dilute.

29
Mr Boyle's account of the colours of thin plates.

The firft diftinct account of the colours exhibited by thin plates of various fubftances, are met with among the obfervations of Mr Boyle. To fhew the chemifts that colours may be made to appear or vanifh, where there is no acceffion or change either of the fulphureous, the faline, or the mercurial principle of bodies, he obferves, that all chemical effential oils, as

as alſo good ſpirit of wine, being ſhaken till they riſe in bubbles, appear of various colours; which immediately vaniſh when the bubbles burſt, ſo that a colourleſs liquor may be immediately made to exhibit a variety of colours, and loſe them in a moment, without any change in its eſſential principles. He then mentions the colours that appear in bubbles of ſoap and water, and alſo in turpentine. He ſometimes got glaſs blown ſo thin as to exhibit ſimilar colours; and obſerves, that a feather, of a proper ſhape and ſize, and alſo a black ribbon, held at a proper diſtance, between his eye and the ſun, ſhewed a variety of little rainbows, as he calls them, with very vivid colours, none of which were conſtantly to be ſeen in the ſame objects.

30 Dr Hooke's account of theſe colours.

Much more pains were taken with this ſubject, and a much greater number of obſervations reſpecting it were made, by Dr Hooke. As he loved to give ſurpriſe by his diſcoveries, he promiſed, at a meeting of the ſociety on the 7th of March 1672, to exhibit, at their next meeting, ſomething which had neither reflection nor refraction, and yet was diaphanous. Accordingly, at the time appointed, he produced the famous coloured bubble of ſoap and water, of which ſuch admirable uſe was afterwards made by Sir Iſaac Newton, but which Dr Hooke and his cotemporaries ſeem to have overlooked in Mr Boyle's treatiſe on colours, tho' it was publiſhed nine years before. It is no wonder that ſo curious an appearance excited the attention of that inquiſitive body, and that they ſhould deſire him to bring an account of it in writing at their next meeting.

By the help of a ſmall glaſs-pipe, there were blown ſeveral ſmall bubbles, out of a mixture of ſoap and water; where it was obſervable, that, at firſt, they appeared white and clear; but that, after ſome time, the film of water growing thinner, there appeared upon it all the colours of the rainbow: Firſt a pale yellow; then orange, red, purple, blue, green, &c. with the ſame ſeries of colours repeated; in which it was farther obſervable, that the firſt and laſt ſeries were very faint, and that the middlemoſt order or ſeries was very bright. After theſe colours had paſſed over the changes above mentioned, the film of the bubble began to appear white again; and preſently, in ſeveral parts of this ſecond white film, there appeared ſeveral holes, which by degrees grew very big, ſeveral of them running into one another. After reciting other obſervations, which are not of much conſequence, he ſays it is ſtrange, that tho' both the encompaſſing and encompaſſed air have ſurfaces, yet he could not obſerve that they afforded either reflection or refraction, which all the other parts of the encompaſſed air did. This experiment, he ſays, at firſt ſight, may appear very trivial, yet, as to the finding out the nature and cauſe of reflection, refraction, colours, congruity and incongruity, and ſeveral other properties of bodies, he looked upon it as one of the moſt inſtructive. And he promiſed to conſider it more afterwards; but we do not find that ever he did; nor indeed is it to be much regretted, as we ſhall ſoon find this buſineſs in better hands. He adds, that that which gives one colour by reflection, gives another by trajection; not much unlike the tincture of lignum nephriticum.

Dr Hooke was the firſt to obſerve, if not to deſcribe, the beautiful colours that appear in thin plates of muſcovy glaſs. Theſe, he ſays, are very beautiful to the naked eye, but much more when they are viewed with a microſcope. With this inſtrument he could perceive that theſe colours were ranged in rings ſurrounding the white ſpecks or flaws in this thin ſubſtance, that the order of the colours was the very ſame as in the rainbow, and that they were often repeated ten times. But the colours, he ſays, were diſpoſed as in the outer bow, and not the inner. Some of them alſo were much brighter than others, and ſome of them very much broader. He alſo obſerved, that if there was a place where the colours were very broad, and conſpicuous to the naked eye, they might be made, by preſſing the place with the finger, to change places, and move from one part to another. Laſtly, he obſerved, that if great care be uſed, this ſubſtance may be ſplit into plates of $\frac{1}{8}$ or $\frac{1}{6}$ of an inch in diameter, each of which will appear thro' a microſcope to be uniformly adorned with ſome one vivid colour, and that theſe plates will be found upon examination to be of the ſame thickneſs throughout.

As a fact ſimilar to this, but obſerved previous to it, we ſhall here mention that Lord Brereton, at a meeting of the Royal Society in 1666, produced ſome pieces of glaſs taken out of a window of a church, both on the north and on the ſouth ſide of it; obſerving, that they were all eaten in by the air, but that the piece taken from the ſouth ſide had ſome colours like thoſe of the rainbow upon it, which the others on the north ſide had not. This phenomenon has been frequently obſerved ſince, and in other circumſtances. It is not to doubted, but that in all theſe caſes, the glaſs is divided into thin plates, which exhibit colours, upon the ſame principle with thoſe which Dr Hooke obſerved in the bubble of ſoap and water, and in the thin plate of air, which we ſhall find more fully explained by Sir Iſaac Newton. With care the thin plates of the glaſs may be ſeparated, and the theory verified.

31 Why the ſtars are viſible by day at the bottom of a well.

An obſervation made by Otto Guericke, well explains the reaſon why ſtars are viſible at the bottom of a deep well. It is, ſays he, becauſe the light that proceeds from them is not overpowered by the rays of the ſun, which are loſt in the number of reflections which they muſt undergo in the pit, ſo that they can never reach the eye of a ſpectator at the bottom of it.

But of all thoſe who have given their attention to this ſubject of the reflection of light, none ſeems to have given ſuch ſatisfaction as M. Bouguer, and next to thoſe of Sir Iſaac Newton, his labours ſeem to have been the moſt ſucceſsful. The object of his curious and elaborate experiments was to meaſure the degrees of light, whether emitted, reflected, or refracted, by different bodies. They were originally occaſioned by an article of M. Mairan's in the Memoirs of the French academy for 1721, in which the proportion of the light of the ſun at the two ſolſtices were ſuppoſed to be known, and his laudable attempt to verify what had been before taken for granted, ſuggeſted a variety of new experiments, and opened to him and to the world a new field of optical knowledge. His firſt production upon this ſubject was a treatiſe intitled *Eſſai d'Optique*, which was received with general approbation. Afterwards,

wards, giving more attention to this ſubject, he formed an idea of a much larger work, to which many more experiments were neceſſary: but he was prevented, by a variety of interruptions, from executing his deſign ſo ſoon as he had propoſed; and he had hardly completed it at the time of his death, in 1758; ſo that we are obliged to his friend M. de la Caille for the care of the publication. At length, however, it was printed at Paris, in 1760, under the title of *Traite d' Optique*.

32 Diſcoveries of M. Bouguer.

At the entrance upon this treatiſe, we are induced to form the moſt pleaſing expectations from our author's experiments, by his account of the variety, the ſingular accuracy, and circumſpection, with which he made them; whereby he muſt, to all appearance, have guarded againſt every avenue to error, and particularly againſt thoſe objections to which the few attempts that had been made, of a ſimilar nature, before him had been liable. In order to compare different degrees of light, he always contrived to place the bodies from which it proceeded, or other bodies illuminated by them, in ſuch a manner as that he could view them diſtinctly at the ſame time; and he either varied the diſtances of theſe bodies, or modified their light in ſome other way, till he could perceive no difference between them. Then, conſidering their different diſtances, or the other circumſtances by which their light was affected, he calculated the proportion which they would have borne to each other at the ſame diſtance, or in the ſame circumſtances.

Plate CCVI fig. 3. To aſcertain the quantity of light loſt by reflection, he placed the mirror, or reflecting ſurface, B, on which the experiment was to be made, truly upright; and having taken two tablets, of preciſely the ſame colour, or of an equal degree of whiteneſs, he placed them exactly parallel to one another at E and D, and threw light upon them by means of a lamp or candle, P, placed in a right line between them. He then placed himſelf ſo that, with his eye at A, he could ſee the tablet E, and the image of the tablet D, reflected from the mirror B, at the ſame time; making them, as it were, to touch one another. He then moved the candle along the line ED, ſo as to throw more or leſs light upon either of them, till he could perceive no difference in the ſtrength of the light that came to his eye from them. After this, he had nothing more to do than to meaſure the diſtances EP and DP; for the ſquares of thoſe diſtances expreſſed the degree in which the reflection of the mirror diminiſhed the quantity of light. It is evident, that if the mirror reflected all the rays it received, the candle P muſt have been placed at C, at an equal diſtance from each of the tablets, in order to make them appear equally illuminated; but becauſe much of the light is loſt in reflection, they can only be made to appear equally bright by placing the candle nearer the tablet D, which is ſeen by reflection only.

Fig. 4. To find how much light is loſt by oblique reflection, he took two equally poliſhed plates, D and E, and cauſed them to be enlightened by the candle P; and while one of them, D, was ſeen at A, by reflection from B, placed in a poſition oblique to the eye, the other, E, was ſo placed, as to appear contiguous to it; and removing the plate E, till the light which it reflected was no ſtronger than that which came from the image D, ſeen by reflection at B, he eſtimated the quantity of light that was loſt by this oblique reflection, by the ſquares of the diſtances of the two objects from the candle.

It need ſcarcely be added, that, in theſe experiments all foreign light was excluded, that his eye was ſhaded, and that every other precaution was obſerved in order to make his concluſions unqueſtionable.

Fig. 5. In order to aſcertain the quantity of light loſt by reflection with the greateſt exactneſs, M. Bouguer introduced two beams of light into a darkened room, as by the apertures P and Q; which he had ſo contrived, that he could place them higher or lower, and enlarge or contract them at pleaſure; and the reflecting ſurface (as that of a fluid contained in a veſſel) was placed horizontally at O, from whence the light coming thro' the hole P, was reflected to R, upon the ſcreen GH, where it was compared with another beam of light that fell upon S, through the hole Q; which he made ſo much leſs than P, as that the ſpaces S and R were equally illuminated; and by the proportion that the apertures P and Q bore to each other, he calculated what quantity of light was loſt by the reflection at O.

It is neceſſary, he obſerves, that the two beams of light PO and QS (which he uſually made 7 or 8 feet long) ſhould be exactly parallel, that they might come from two points of the ſky equally elevated above the horizon, and having preciſely the ſame intenſity of light. It was alſo neceſſary that the hole Q ſhould be a little higher than P, in order that the two images ſhould be at the ſame height, and near one another. It is no leſs neceſſary, he ſays, that the ſcreen GH be exactly vertical, in order that the direct and reflected beams may fall upon it with the ſame inclination; ſince, otherwiſe, though the two lights were perfectly equal, they would not illuminate the ſcreen equally. This diſpoſition, he ſays, ſerves to anſwer another important condition in theſe experiments; for the direct ray QS muſt be of the ſame length with the ſum of the incident and reflected rays, PO and OR, in order that the quantity of light introduced into the room may be ſenſibly proportional to the ſizes of the apertures.

We ſhall now proceed to recite the reſult of the experiments which he made to meaſure the quantity of light that is loſt by reflection in a great variety of circumſtances; but we ſhall introduce them by the recital of ſome which were made previous to them on the diminution of light by reflection, and the tranſmiſſion of it to conſiderable diſtances through the air, by M. Buffon, at the time that he was conſtructing his machine to burn at great diſtances, mentioned under the article Burning-*Glaſs*.

33 Of Mr Buffon.

Receiving the light of the ſun in a dark place, and comparing it with the ſame light of the ſun reflected by a mirror, he found, that at ſmall diſtances, as four or five feet, about one half was loſt by reflection; as he judged by throwing two reflected beams upon the ſame place, and comparing them with a beam of direct light; for then the intenſity of them both ſeemed to be the ſame.

Having received the light at greater diſtances, as at 100, 200, and 300 feet, he could hardly perceive that it loſt any of its intenſity by being tranſmitted through ſuch a ſpace of air.

He afterwards made the ſame experiments with candles, in the following manner: He placed himſelf oppoſite

opposite to a looking-glass, with a book in his hand, in a room perfectly dark; and having one candle lighted in the next room, at the distance of about 40 feet, he had it brought nearer to him by degrees, till he was just able to distinguish the letters of the book, which was then 24 feet from the candle. He then received the light of the candle, reflected by the looking-glass, upon his book, carefully excluding all the light that was reflected from any thing else; and he found that the distance of the book from the candle, including the distance from the book to the looking-glass (which was only half a foot) was in all 15 feet. He repeated the experiment several times, and always with nearly the same result; and therefore concluded, that the quantity of direct light is to that of reflected as 576 to 225; so that the light of five candles reflected from a plane mirror is about equal to that of two candles.

From these experiments it appeared, that more light was lost by reflection of the candles than of the sun, which M. Buffon thought was owing to this circumstance, that the light issuing from the candle diverges, and therefore falls more obliquely upon the mirror than the light of the sun, the rays of which are nearly parallel.

These experiments and observations of M. Buffon are curious; though it will be seen that they fall far short of those of M. Bouguer, both in extent and accuracy. We shall begin with those which he made to ascertain the difference in the quantity of light reflected by glass and polished metal.

34 Mr Bouguer's discoveries concerning the reflection of glass and polished metal.

Using a smooth piece of glass one line in thickness, he found, that when it was placed at an angle 15 degrees with the incident rays, it reflected 628 parts of 1000 which fell upon it; at the same time that a metallic mirror, which he tried in the same circumstances, reflected only 561 of them. At a less angle of incidence much more light was reflected; so that at an angle of three degrees the glass reflected 700 parts, and the metal something less, as in the former case.

Trying the reflection of bodies that were not polished, he found that a piece of white plaster, placed at an angle of 75°, with the incident rays, reflected $\frac{1}{119}$ part of the light is received from a candle, nine inches from it. White paper, in the same circumstances, reflected in the same proportion; but at the distance of three inches, they both reflected 150 parts of 1000 that were incident.

Proceeding to make farther observations on the subject of reflected light, he premises the two following theorems, which he demonstrates geometrically. 1. When the luminous body is at an infinite distance, and its light is received by a globe, the surface of which has a perfect polish, and absorbs no light, it reflects the light equally in all directions, provided it be received at a considerable distance. He only excepts the place where the shadow of the globe falls; but this, he says, is no more than a single point, with respect to the immensity of the spherical surface which receives its light.

2. The quantity of light reflected in one certain direction will always be exactly the same, whether it be reflected by a very great number of small polished hemispheres, by a less number of larger hemispheres, or by a single hemisphere, provided they occupy the same base, or cover the same ground-plan.

The use he proposes to make of these theorems is to assist him in distinguishing whether the light reflected from bodies be owing to the extinction of it within them, or whether the roughness or eminences which cover them have not the same effect with the small polished hemispheres above-mentioned.

He begins with observing, that, of the light reflected from Mercury, $\frac{1}{4}$ at least is lost, and that probably no substances reflect more than this. The rays were received at an angle of $11\frac{1}{2}$ degrees of incidence, that is measured from the surface of the reflecting body, and not from the perpendicular, which, he says, is what we are from this place to understand whenever he mentions the angle of incidence.

35 Great differences in the reflective power of substances according to the angle of incidence.

The most striking observations which he made with respect to this subject, are those which relate to the very great difference in the quantity of light reflected at different angles of incidence. In general, he says, that reflection is stronger at small angles of incidence, and weaker at large ones. The difference is excessive when the rays strike the surface of transparent substances, with different degrees of obliquity; but it is almost as great in some opaque substances, and it was always more or less so in every thing that he tried. He found the greatest inequality in black marble; in which he was astonished to find, that, with an angle of 3° 35′ of incidence, though not perfectly polished, yet it reflected almost as well as quick-silver. Of 1000 rays which it received, it returned 600; but when the angle of incidence was 14 degrees, it reflected only 156; when it was 30, it reflected 51; and when it was 80, it reflected only 23.

Similar experiments made with metallic mirrors always gave the differences much less considerable. The greatest was hardly ever an eighth or a ninth part of it, but they were always in the same way.

The great difference between the quantity of light reflected from the surface of water, at different angles of incidence, is truly surprising; but our author observes, that this difference was greater when the smallest inclinations were compared with those which were near to a right angle. He sometimes suspected that, at very small angles of incidence, the reflection from water was even greater than from quick-silver. All things considered, he thought it was not quite so great, though it was very difficult to determine the precise difference between them. In very small angles, he says, that water reflects nearly $\frac{3}{4}$ of the direct light.

There is no person, he says, but has sometimes felt the force of this strong reflection from water, when he has been walking in still weather on the brink of a lake opposite to the sun. In this case, the reflected light is $\frac{1}{3}$, $\frac{1}{2}$, or sometimes a greater proportion of the light that comes directly from the sun, which is an addition to the direct rays of the sun that cannot fail to be very sensible. The direct light of the sun diminishes gradually as it approaches the horizon, while the reflected light at the same time grows stronger: so that there is a certain elevation of the sun, in which the united force of the direct and reflected light will be the greatest possible, and this he says is 12 or 13 degrees.

On the other hand, the light reflected from water at great angles of incidence is extremely small. Our author was assured, that, when the light was perpendicular, it reflected no more than the 37th part that quick-

quickfilver does in the fame circumftances; for it did not appear, from all his obfervations, that water reflects more than the 60th, or rather the 55th, part of perpendicular light. When the angle of incidence was 50 degrees, the light reflected from the furface of water was about the 32d part of that which mercury reflected; and as the reflection from water increafes with the diminution of the angle of incidence, it was twice as ftrong in proportion at 39 degrees; for it was then the 16th part of the quantity that mercury reflected.

In order to procure a common ftandard by which to meafure the proportion of light reflected from various fluid fubftances, he pitched upon water as the moft commodious; and partly by obfervation, and partly by calculation, which he always found to agree with his obfervations, he drew up the following table of the quantity of light reflected from the furface of water, at different angles with the furface.

Angles of incidence.	Rays reflected of 1000.	Angles of incidence.	Rays reflected of 1000.
$\frac{1}{2}$	721	17 $\frac{1}{2}$	178
1	692	20	145
1 $\frac{1}{2}$	669	25	97
2	639	30	65
2 $\frac{1}{2}$	614	40	34
5	501	50	22
7 $\frac{1}{2}$	409	60	19
10	333	70	18
12 $\frac{1}{2}$	271	80	18
15	211	90	18

In the fame manner, he drew up the following table, of the quantity of light reflected from the looking-glafs not quickfilvered.

Angles of incidence.	Rays reflected of 1000.	Angles of incidence.	Rays reflected of 1000.
2 $\frac{1}{2}$	584	30	112
5	543	40	57
7 $\frac{1}{2}$	474	50	34
10	412	60	27
12 $\frac{1}{2}$	356	70	25
15	299	80	25
20	222	90	25
25	157		

Pouring a quantity of water into a veffel containing quickfilver, it is evident that there will be two images of any objects feen by reflection from them, one at the furface of the water, and the other at that of the quickfilver. In the largeft angles of incidence, the image at the furface of the water will difappear, which will happen when it is about a 60th or an 80th part lefs luminous than the image at the furface of the quickfilver. Depreffing the eye, the image on the water will grow ftronger, and that on the quickfilver weaker in proportion; till at laft, the latter will be incomparably weaker than the former, and at an angle of about 10 degrees they will be equally luminous. According to the table, $\frac{333}{1000}$ of the incident rays are reflected from the water at this angle of 10 degrees. At the furface of the mercury, they were reduced to 500; and of thefe, part being reflected back upon it from the under furface of the water, only 333 remained to make the image from the mercury.

36 Reflection of images by the air.

It has been obferved by feveral perfons, particularly by Mr Edwards, (fee Phil. Tranf. vol. 53. p. 229.) that there is a remarkably ftrong reflection into water, with refpect to rays iffuing from the water; and perfons under water have feen images of things in the water in a manner peculiarly diftinct and beautiful: but this fact had not been obferved with a fufficient degree of attention, till it came into M. Bouguer's way to do it, and he acknowledges it to be very remarkable. In this cafe, he fays, that from the fmalleft angles of incidence, to a certain number of degrees, the greateft part of the rays are reflected, perhaps in as great a proportion as at the furface of metallic mirrors, or of quickfilver; while the other part, which does not efcape into the air, is extinguifhed or abforbed; fo that the furface of the tranfparent body appears opaque on the infide. If the angle of incidence be increafed only a few degrees, the ftrong reflection ceafes altogether, a great number of rays efcape into the air, and very few are abforbed or extinguifhed. In poportion as the angle of incidence is farther increafed, the quantity of the light reflected becomes lefs and lefs; and when it is near 90 degrees, almoft all the rays efcape out of the tranfparent body, its furface lofing almoft all its power of reflection, and becoming almoft as tranfparent as it is in other cafes, or when the light falls upon it from without.

37 Extinction of the rays of light at the furfaces of tranfparent bodies.

This property belonging to the furfaces of tranfparent bodies, of abforbing or extinguifhing the rays of light, is truly remarkable, and, as there is reafon to believe, had not been noticed by any perfon before M. Bouguer. It had been conjectured by Sir Ifaac Newton, that rays of light become extinct only by impinging upon the folid part of bodies; but thefe obfervations of M. Bouguer fhew that the fact is quite otherwife; and that this effect is to be attributed, not to the folid parts of bodies, which are certainly more numerous in a long tract of water than juft in the paffage out of water into air, but to fome power lodged at the furfaces of bodies only, and therefore probably the fame with that which reflects, refracts, and inflects the light.

38 Strong reflection by a prifm.

One of the above-mentioned obfervations, *viz.* all the light being reflected at certain angles of incidence from air into denfer fubftances, had frequently been obferved, efpecially in glafs prifms; fo that Newton made ufe of one of them inftead of a reflecting mirror, in the conftruction of his telefcope. If a beam of light fall upon the air from within thefe prifms, at an angle of 10, 20, or 30 degrees, the effect will be nearly the fame as at the furface of quickfilver, a fourth or a third of the rays being extinguifhed, and $\frac{2}{3}$ or $\frac{3}{4}$ths reflected. This property retains its full force as far as an incidence of 49° 49′, (fuppofing the proportion of the fines of refraction to be 31 and 20 for the mean refrangible rays); but if the angle of incidence be increafed but one degree, the quantity of light reflected inwards decreafes fuddenly, and a great part of the rays efcape out of the glafs, fo that the furface becomes fuddenly tranfparent.

All tranfparent bodies have the fame property, with this difference, that the angle of incidence at which the ftrong

ſtrong reflection ceaſes, and at which the light which is not reflected is extinguiſhed, is greater in ſome than in others. In water this angle is about 41° 32′; and in every medium it depends ſo much on the invariable proportion of the ſine of the angle of refraction to the ſine of the angle of incidence, that this law alone is ſufficient to determine all the phenomena of this new circumſtance, at leaſt as to this accidental opacity of the ſurface.

When our author proceeded to meaſure the quantity of light reflected by theſe internal ſurfaces at great angles of incidence, he found many difficulties, eſpecially on account of the many alterations which the light underwent before it came to his eye: but at length, uſing a plate of cryſtal, he found, that, at an angle of 75 degrees, this internal reflection diminiſhed the light 27 or 28 times; and as the external reflection at the ſame angle diminiſhed the light only 26 times, it follows that the internal reflection is a little ſtronger than the other.

Repeating theſe experiments with the ſame and different pieces of cryſtal, he ſometimes found the two reflections to be equally ſtrong; but, in general, the internal was the ſtronger. Alſo, the image reflected internally was always a little redder than an object which was ſeen directly through the plate of cryſtal.

39 Of the quantity of light reflected by different ſubſtances.

Reſuming his obſervations on the diminution of light, occaſioned by the reflection of opaque bodies obliquely ſituated, he compared it with the appearances of ſimilar ſubſtances which reflected the light perpendicularly. Uſing pieces of ſilver made very white, he found, that, when one of them was placed at an angle of 75 degrees with reſpect to the light, it reflected only 640 parts out of 1000. He then varied the angle, and alſo uſed white plaſter and fine Dutch paper, and drew up the following table of the proportion of the light reflected from each of thoſe ſubſtances at certain angles.

INTENSITY of LIGHT reflected from

Angles of incidence.	Silver.	Plaſter.	Dutch Paper.
90	1000	1000	1000
75	802	762	971
60	640	640	743
45	455	529	507
30	319	352	332
15	209	194	203

Suppoſing the aſperities of opaque bodies to conſiſt of very ſmall planes, it appears from theſe obſervations, that there are fewer of them in theſe bodies which reflect the light at ſmall angles of incidence than at greater; and our author ſays, that the caſe was nearly the ſame with reſpect to all the opaque bodies that he tried. None of them had their roughneſs equivalent to ſmall hemiſpheres, which would have diſperſed the light equally in all directions; and, from the *data* in the preceding table, he deduces mathematically the number of the little planes that compoſe thoſe ſurfaces, and that are inclined to the general ſurface at the angles above-mentioned, ſuppoſing that the whole ſurface contains 1000 of them that are parallel to itſelf, ſo as to reflect the light perpendicularly, when the luminous body is ſituated at right angles with reſpect to it. His concluſions reduced to a table, correſponding to the preceding, are as follows:

Inclinations of the ſmall ſurfaces with reſpect to the large one.	The diſtribution of the ſmall planes that conſtitute the aſperities of the opaque ſurface in the		
	Silver.	Plaſter.	Paper.
0	1000	1000	1000
15	777	736	937
30	554	554	545
45	333	374	358
60	161	176	166
75	53	50	52

Theſe variations in the number of little planes, or ſurfaces, he expreſſes in the form of a curve; and afterwards he ſhews, geometrically, what would be the effect, if the bodies were enlightened in one direction, and viewed in another; upon which ſubject he has ſeveral curious theorems and problems: as, the poſition of the eye being given, to find the angle at which the luminous body muſt be placed, in order to its reflecting the moſt light; or, the ſituation of the luminous body being given, to find a proper ſituation for the eye, in order to ſee it the moſt enlightened, &c. But it would carry us too far into geometry to follow him through all theſe diſquiſitions.

Since the planets, as this accurate obſerver takes notice, are more luminous at their edges than at their centres, he concludes, from the abovementioned principles, that the bodies which form them are conſtituted in a manner different from ours; particularly that their opaque ſurfaces conſiſt of ſmall planes, more of which are inclined to the general ſurface than they are in terreſtrial ſubſtances; and that there are in them an infinity of points, which have exactly the ſame ſplendour. 40 Obſervations concerning the planets, &c.

Our philoſopher and geometrician next proceeds to aſcertain the quantity of ſurface occupied by the ſmall planes of each particular inclination, from conſidering the quantity of light reflected by each, allowing thoſe that have a greater inclination to the common ſurface to take up proportionably leſs ſpace than thoſe which are parallel to it. And comparing the quantity of light that would be reflected by ſmall planes thus diſpoſed, with the quantity of light that was actually reflected by the three ſubſtances abovementioned, he found, that plaſter, notwithſtanding its extreme whiteneſs, abſorbs much light; for that, of 1000 rays that fall upon it, of which 166 or 167 ought to be reflected at an angle of 77 degrees, only 67 are in fact returned; ſo that 100 out of 167 were extinguiſhed, that is, about three-fifths.

With reſpect to the planets, our author concludes, that of 300,000 rays which the moon receives, 172,000 are abſorbed, or perhaps 204,100.

Having conſidered the ſurfaces of bodies as conſiſting of planes only, he thus explains himſelf.—Each ſmall ſurface, ſeparately taken, is extremely irregular, and ſome of them are really concave, and others convex; but, in reducing them to a middle ſtate, they are to be conſidered as planes. Nevertheleſs he conſiders them 41 Of the ſurfaces of bodies.

them as planes only with respect to the reception of the rays; for as they are almost all curves, and as, besides this, many of those whose situation is different from others contribute to the same effect, the rays always issue from an actual or imaginary focus, and after reflection always diverge from one another.

If it be asked what becomes of those rays that are reflected from one asperity to another, he shews that very few of the rays can be in those circumstances; since they must fall upon planes which have more than 45 degrees of obliquity to the surface, of which there are very few in natural bodies. These rays must also fall at the bottom of those planes, and must meet with other planes similarly situated to receive them; and considering the great irregularity of the surfaces of opaque bodies, it may be concluded that very few of the rays are thus reflected upon the body itself; and that the little that is so reflected is probably lost to the spectators, being extinguished in the body.

42 Mr Melville's observations on the manner in which bodies are heated by light.

We are obliged to Mr Melville for some ingenious observations on the manner in which bodies are heated by light. He observes, that, as each colorific particle of an opaque body must be somewhat moved by the reaction of the particles of light, when it is reflected backwards and forwards between the same particles, it is manifest that they must likewise be agitated with a vibratory motion, and the time of a vibration will be equal to that which light takes up in moving from one particle of a body to another adjoining. This distance, in the most solid opaque bodies, cannot be supposed greater than $\frac{1}{12500}$th of an inch, which space a particle of light describes in the $\frac{1}{125000000000000}$th of a second. With so rapid a motion, therefore, may the internal parts of bodies be agitated by the influence of light, as to perform 125,000,000,000,000 vibrations, or more, in a second of time.

The arrival of different particles of light at the surface of the same colorific particle, in the same or different rays, may disturb the regularity of its vibrations, but will evidently increase their frequency, or raise still smaller vibrations among the parts which compose those particles; by which means the intestine motion will become more subtle, and more thoroughly diffused. If the quantity of light admitted into the body be increased, the vibrations of the particles must likewise increase in magnitude and velocity, till at last they may be so violent, as to make all the component particles dash one another to pieces by their mutual collision; in which case, the colour and texture of the body must be destroyed.

Since there is no reflection of light but at the surface of a medium, the same person observes, that the greatest quantity of rays, though crowded into the smallest space, will not of themselves produce any heat. From hence it follows, that the portion of air which lies in the focus of the most potent speculum, is not at all affected by the passage of light through it, but continues of the same temperature with the ambient air; though any opaque body, or even any transparent body denser than air, when put in the same place, would be intensely heated in an instant.

This consequence, evidently flowing from the plainest and most certain principles, not seeming to have been rightly understood by many philosophers; and even the silence of most physical writers concerning this paradoxical truth making it probable that they were unacquainted with it, he thought it worth his while to say something in explication of it. He observes, that the easiest way to be satisfied of the matter experimentally is, to hold a hair, or a piece of down, immediately above the focus of a lens or speculum, or to blow a stream of smoke from a pipe horizontally over it; for if the air in the focus were hotter than the surrounding fluid, it would continually ascend upon account of its rarefaction, and thereby sensibly agitate those slender bodies. Or a lens may be so placed as to form its focus within a body of water, or some other transparent substance, the heat of which may be examined from time to time with a thermometer; but care must be taken, in this experiment, to hold the lens as near as possible to the transparent body, lest the rays, by falling closer than ordinary on its surface, should warm it more than the common sunbeams.

To apply these observations to the explication of natural phenomena, he observes, that the atmosphere is not much warmed by the passage of the sun's light through it, but chiefly by its contact with the heated surface of the globe. This, he thought, furnished one very simple and plausible reason why it is coldest in all climates on the tops of very high mountains; namely, because they are removed to the greatest distance from the general surface of the earth. For it is well known, that a fluid heated by its contact with a solid body, decreases in heat in some inverse proportion to the distance from the body. He himself found, by repeated trials, that the heat of water in deep lakes decreases regularly from the surface downwards. But to have this question fully determined, the temperature of the air in the valley and on the mountain-top must be observed every hour, both night and day, and carefully compared together.

From this doctrine he thinks it reasonable to suppose, that the heat produced by a given number of rays, in an opaque body of a given magnitude, must be greater when the rays are more inclined to one another, than when they are less so; for the direction of the vibrations raised by the action of the light, whether in the colorific particles, or those of an inferior order, will more interfere with one another; from whence the intestine shocks and collisions must increase. Besides this, the colorific particles of opaque bodies being disposed in various situations, perhaps, upon the whole, the rays will fall more directly on each, the more they are inclined to one another. Is not this, says he, the reason of what has been remarked by philosophers, that the heat of the sun's light, collected into a cone, increases in approaching the focus in a much higher proportion than according to its density? That the difference of the angle in which the rays fall on any particle of a given magnitude, placed at different distances from the focus, is but small, is no proof that the phenomenon cannot be ascribed to it; since we know not in what high proportion one or both the circumstances now mentioned may operate. However, that it proceeds not from any unknown action of the rays upon one another, as has been insinuated, is evident from this, that each particular ray, after passing through the focus, preserves its own colour and its own direction, in the same manner

manner as if it were alone.

43 Abbé Nollet's experiments with burning-glasses.

The attempts of the Abbé Nollet to fire inflammable substances by the power of the solar rays collected in the foci of burning mirrors, have a near relation to the present subject. Considering the great power of burning mirrors and lenses, especially those of late construction, it will appear surprising that this celebrated experimental philosopher should not be able to fire any liquid substance. But though he made the trial with all the care imaginable on the 19th of February 1757, he was not able to do it either with spirit-of-wine, olive-oil, oil-of-turpentine, or æther; and though he could fire sulphur, yet he could not succeed with Spanish-wax, rosin, black pitch, or suet. He both threw the focus of these mirrors upon the substances themselves, and also upon the fumes that rose from them; but all the effect was, that the liquor boiled, and was dispersed in vapour or very small drops, but would not take fire. When linen-rags, and other solid substances, were moistened with any of these inflammable liquids, they would not take fire till the liquid was dispersed in a copious fume; so that rags thus prepared were longer in burning than those that were dry.

44 M. Beaume's experiments.

M. Beaume, who assisted M. Nollet in some of these experiments, observed farther, that the same substances which were easily fired by the flame of burning bodies, could not be set on fire by the contact of the hottest bodies that did not actually flame. Neither æther nor spirit-of-wine could be fired with a hot coal, or even red-hot iron, unless they were of a white heat. From these experiments our author concludes, that, supposing the electric matter to be the same thing with fire or light, it must fire spirit-of-wine by means of some other principle. The members of the academy Del Cimento had attempted to fire several of these substances, though without success; but this was so early in the history of philosophy, that nobody seems to have concluded, that, because they failed in this attempt, the thing could not be done. However, the Abbé informs us, that he read an account of his experiments to the Royal Academy at Paris several years before he attended to what had been done by the Italian philosophers.

45 Bodies which seem to touch one another are not actually in contact.

By the help of optical principles, and especially observations on the reflection of light, Mr Melville discovered that bodies which seem to touch one another are not always in actual contact. "It is common (says he) to admire the volubility and lustre of drops of rain that lie on the leaves of colewort, and some other vegetables;" but no philosopher, as far as he knew, had put himself to the trouble of explaining this curious phenomenon. Upon inspecting them narrowly, he found that the lustre of the drop is produced by a copious reflection of light from the flattened part of its surface contiguous to the plant. He observed farther, that, when the drop rolls along a part which has been wetted, it immediately loses all its lustre, the green plant being then seen clearly through it; whereas, in the other case, it is hardly to be discerned.

From these two observations put together, he concluded, that the drop does not really touch the plant, when it has the mercurial appearance, but is suspended in the air at some distance from it by the force of a repulsive power. For there could not be any copious reflection of white light from its under-surface, unless there were a real interval between it and the surface of the plant.

If that surface were perfectly smooth, the under-surface of the drop would be so likewise, and would therefore shew an image of the illuminating body by reflection, like a piece of polished silver; but as it is considerably rough and unequal, the under-surface becomes rough likewise, and so, by reflecting the light copiously in different directions, assumes the resplendent white colour of unpolished silver.

It being thus proved by an optical argument, that the drop is not really in contact with the plant which supports it, it may easily be conceived whence its volubility arises, and why it leaves no moisture where it rolls.

46 Two curious miscellaneous observations.

Before we conclude the history of the observations concerning the reflection of light, we must not omit to take notice of two curious miscellaneous ones. Baron Alexander Funk, visiting some silver-mines in Sweden, observed that, in a clear day, it was as dark as pitch under-ground in the eye of a pit, at 60 or 70 fathoms deep; whereas, in a cloudy or rainy day, he could even see to read at 106 fathoms deep. Inquiring of the miners, he was informed that this is always the case; and, reflecting upon it, he imagined that it arose from this circumstance, that when the atmosphere is full of clouds, light is reflected from them into the pit in all directions, and that thereby a considerable proportion of the rays are reflected perpendicularly upon the earth; whereas, when the atmosphere is clear, there are no opaque bodies to reflect the light in this manner, at least in a sufficient quantity; and rays from the sun itself can never fall perpendicularly in that country. The other was that of the ingenious Mr Grey, who makes such a figure in the history of electricity. This gentleman took a piece of stiff brown paper, and pricking a small hole in it, he held it at a little distance before him; when, applying a needle to his eye, he was surprised to see the point of it inverted. The nearer the needle was to the hole, the more it was magnified, but the less distinct; and if it was so held, as that its image was near the edge of the hole, its point seemed crooked. From these appearances he concluded, that these small holes, or something in them, produce the effects of concave speculums; and from this circumstance he took the liberty to call them *aërial speculums*.

§ 4. *Discoveries concerning the Inflection of Light.*

This property of light was not discovered till about the middle of the last century. The person who first made the discovery was Father Grimaldi; at least he first published an account of it in his treatise *De lumine, coloribus, et iride*, printed in 1666. Dr Hooke, however, laid claim to the same discovery, though he did not publish his observations till six years after Grimaldi; having probably never seen his performance.

47 Dr Hooke's discoveries.

Dr Hooke having made his room completely dark, admitted into it a beam of the sun's light by a very small hole in a brass plate fixed in the window-shutter. This beam spreading itself, formed a cone, the apex of which was in the hole, and the base was on a paper,

so placed, as to receive it at some distance. In this image of the sun, thus painted on the paper, he observed, that the middle was much brighter than the edges, and that there was a kind of dark penumbra about it, of about a 16th part of the diameter of the circle; which penumbra, he says, must be ascribed to a property of light, which he promised to explain.—Having observed this at the distance of about two inches from the former, he let in another cone of light; and receiving the bases of them, at such a distance from the holes as that the circles intersected each other, he observed that there was not only a penumbra, or darker ring, encompassing the lighter circle, but a manifest dark line, or circle, which appeared even where the limb of the one interfered with that of the other. This appearance is distinctly represented, Plate CCVI fig. 6.

Comparing the diameter of this base with its distance from the hole, he found it to be by no means the same as it would have been if it had been formed by straight lines drawn from the extremities of the sun's disk, but varied with the size of the holes, and the distance of the paper.

Struck with this appearance, he proceeded to make farther experiments concerning the nature of light thus transmitted. To give a just idea of which, he held an opaque body BB, fig. 7, so as to intercept the light that entered at a hole in the window-shutter O, and was received on the screen AP. In these circumstances, he observed, that the shadow of the opaque body (which was a round piece of wood, not bright or polished) was all over somewhat enlightened, but more especially towards the edge. Some persons who were present, imagining that this light within the shadow might be produced by some kind of reflection from the side of this opaque body, on account of its roundness; and others supposing it might proceed from some reflection from the sides of the hole in the piece of brass through which the light was admitted into the room; to obviate both these objections, he admitted the light through a hole burnt in a piece of pasteboard, and intercepted it with a razor which had a very sharp edge; but still the appearances were the very same as before: so that, upon the whole, he concluded that they were occasioned by a new property of light, different from any that had been observed by preceding writers.

He farther diversified this experiment, by placing the razor so as to divide the cone of light into two parts, the hole in the shutter remaining as before, and placing the paper so as that none of the enlightened part of the circle fell upon it, but only the shadow of the razor; and, to his great surprise, he observed what he calls a *very brisk and visible radiation* striking down upon the paper, of the same breadth with the diameter of the lucid circle; and this radiation always struck perpendicularly from the line of shadow, and, like the tail of a comet, extended more than 10 times, and probably more than 100 times the breadth of the remaining part of the circle: nay, as far as he could find, by many trials, the light from the edge struck downwards into the shadow very near to a quadrant, though the greater were the deflections of this new light from the direct radiations of the cone, the more faint they were.

Observing this appearance with more attention, he found, wherever there was a part of the interposed body higher than the rest, that, opposite to it, the radiation of light into the shadow was brighter, as in the figure; and wherever there was a notch or gap in it, there would be a dark stroke in the half-enlightened shadow. From all these appearances, he concluded that they were to be ascribed to a new property of light, whereby it is deflected from straight lines, contrary to what had been before asserted by optical writers.

It does not appear, however, that our philosopher ever prosecuted this experiment to any purpose; as all that we find of his on the subject of light, after this time, are some crude thoughts which he read at a meeting of the Royal Society, on the 18th of March 1675; which, however, as they are only short hints, we shall copy.

They consist of eight articles; and, as he thought, contained an account of several properties of light, that had not been noticed before. There is a deflection of light, differing both from reflection and refraction, and seeming to depend on the unequal density of the constituent parts of the ray, whereby the light is dispersed from the place of condensation, and rarified, or gradually diverged into a quadrant. 2. This deflection is made towards the superficies of the opaque body perpendicularly. 3. Those parts of the diverged radiations which are deflected by the greatest angle from the straight or direct radiations are the faintest, and those that are deflected by the least angles are the strongest. 4. Rays cutting each other in one common foramen do not make the angles at the vertex equal. 5. Colours may be made without refraction. 6. The diameter of the sun cannot be truly taken with common sights. 7. The same rays of light, falling upon the same point of an object, will turn into all sorts of colours, by the various inclination of the object. 8. Colours begin to appear when two pulses of light are blended so well, and so near together, that the sense takes them for one.

48 Grimaldi's discoveries.

We shall now proceed to the discoveries of Father Grimaldi. Having introduced a ray of light, through a very small hole, AB, fig. 8. into a darkened room, he observed that the light was diffused in the form of a cone, the base of which was CD; and that if any opaque body, FE, was placed in this cone of light, at a considerable distance from the hole, and the shadow was received upon a piece of white paper, the boundaries of it were not confined within GH, or the penumbra IL, occasioned by the light proceeding from different parts of the aperture, and of the disk of the sun, but extended to MN; at which he was very much surprised, suspecting, and finding by calculation, that it was considerably broader than it could have been made by rays passing in right lines by the edges of the object.

But the most remarkable circumstance in this appearance was, that upon the lucid part of the base, CM and ND, streaks of coloured light were plainly distinguished, each being terminated by blue on the side next to the shadow, and by red on the other; and though these coloured streaks depended, in some measure, on the size of the aperture AB, because they could not be made to appear if it was large, yet he

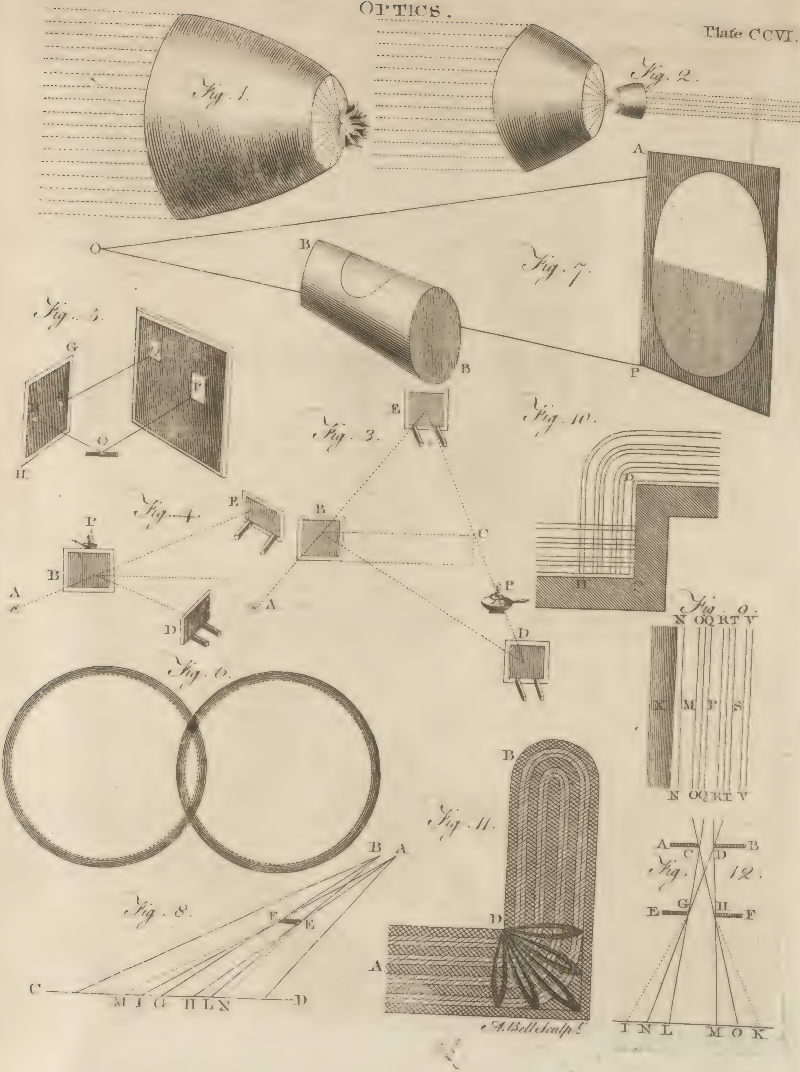


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
N OQ RT V
X M P S
N OQ RT V
A C D B
E G H F
I N L M O K
C M I G H L N D
A. Bell Sculp.

he found that they were not limited either by it, or by the diameter of the ſun's diſk.

He farther obſerved, that theſe coloured ſtreaks were not all of the ſame breadth, but grew narrower as they receded from the ſhadow, and were each of them broader the farther the ſhadow was received from the opaque body, and alſo the more obliquely the paper on which they were received was held with reſpect to it. He never obſerved more than three of theſe ſtreaks.

To give a clearer idea of theſe coloured ſtreaks, he drew the repreſentation of them, exhibited in fig. 9. in which NMO repreſents the broadeſt and moſt luminous ſtreak, next to the dark ſhadow X. In the ſpace in which M is placed there was no diſtinction of colour, but the ſpace NN was blue, and the ſpace OO, on the other ſide of it, was red. The ſecond ſtreak, QPR, was narrower than the former; and of the three parts of which it conſiſted, the ſpace P had no particular colour, but QQ was a faint blue, and RR a faint red. The third ſtreak, TSV, was exactly ſimilar to the two others, but narrower than either of them, and the colours ſtill fainter.

Theſe coloured ſtreaks he obſerved to lie parallel to the ſhadow of the opaque body; but when it was of an angular form, they did not make the ſame acute angles, but were bent into a curve, the outermoſt being rounder than thoſe that were next the ſhadow, as is repreſented in fig. 10. If it was an inward angle, as DCH, the coloured ſtreaks, parallel to each other of the two ſides, croſſed without obliterating one another; only the colours were thereby rendered either more intenſe, or mixed.

The light that formed theſe coloured ſtreaks, the reader will perceive, muſt have been bent from the body; but this attentive obſerver has likewiſe given an account of other appearances, which muſt have been produced by the light bending towards the body. For within the ſhadow itſelf he ſometimes perceived coloured ſtreaks, ſimilar to thoſe above-mentioned on the outſide of the ſhadow. Sometimes he ſaw more of them, and ſometimes fewer: but for this purpoſe a very ſtrong light was requiſite, and the opaque body was obliged to be long, and of a moderate breadth; which, he ſays, is eaſily found by experience. A hair, for inſtance, or a fine needle, did not anſwer ſo well as a thin and narrow plate; and the ſtreaks were moſt diſtinguiſhable when the ſhadow was taken at the greateſt diſtance; but then the light grew fainter in the ſame proportion.

The number of theſe ſtreaks within the ſhadow was greater in proportion to the breadth of the plate. They were at leaſt two, and ſometimes four, if a thicker rod were made uſe of. But, with the ſame plate or rod, more or fewer ſtreaks appeared, in proportion to the diſtance at which the ſhadow was received; but they were broader when they were few, and narrower when there were more of them; and they were all much more diſtinct when the paper was held obliquely.

Theſe coloured ſtreaks within the ſhadow, like thoſe on the outſide of it, were bent in an arch, round the acute angles of the ſhadow, as they are repreſented in fig. 11. At this angle alſo, as at D, other ſhorter lucid ſtreaks were viſible, bent in the form of a plume, as they are drawn betwixt D and C, each bending round and meeting again in D. Theſe angular ſtreaks appeared, though the plate or rod was not wholly immerſed in the beam of light, but the angle of it only; and there were more or fewer in number, in proportion to the breadth of the rod or plate. If the plate or rod was very thin, the coloured ſtreaks within the ſhadow might be ſeen to bend round from the oppoſite ſides, and meet one another, as at B. A only repreſents a ſection of the figure, and not a proper termination of the ſhadow, and the ſtreaks within each ſide of it. The coloured ſtreaks without the ſhadow, he alſo obſerves, bend round it in the ſame manner.

Our author acknowledges, that he omits ſeveral obſervations of leſs conſequence, which cannot but occur to any perſon who ſhall make the experiment; and he ſays, that he was not able to give a perfectly clear idea of what he has attempted to deſcribe, nor does he think it in the power of words to do it.

In order to obtain the more ſatisfactory proof that rays of light do not always proceed in ſtraight lines, but really bend, in paſſing by the edges of bodies, he diverſified the firſt of the above-mentioned experiments in the following manner. He admitted a beam of light, by a very ſmall aperture, into a darkened room, as before; and, at a great diſtance from it, he fixed a plate EF, fig. 12. with a ſmall aperture, GH, which admitted only a part of the beam of light, and found, that when the light tranſmitted through this plate, was received at ſome diſtance, upon a white paper, the baſe IK was conſiderably larger than it could poſſibly have been made by rays iſſuing in the light lines through the two apertures, as the other ſtraight lines drawn cloſe to their edges plainly demonſtrate.

That thoſe who chooſe to repeat theſe experiments may not be diſappointed in their expectations from them, our author gives the following more particular inſtructions. The ſun's light muſt be very intenſe, and the apertures through which it is tranſmitted very narrow, particularly the firſt, CD, and the white paper, IK, on which it is received, muſt be at a conſiderable diſtance from the hole GH; otherwiſe it will not much exceed NO, which would be the breadth of the beam of light proceeding in ſtraight lines. He generally made the aperture CD $\frac{4}{100}$ or $\frac{5}{100}$ part of an ancient Roman foot, and the ſecond aperture, GH, $\frac{25}{100}$ or $\frac{30}{100}$; and the diſtances DG and GN were, at leaſt, 12 ſuch feet. The obſervation was made in the ſummer-time, when the atmoſphere was free from all vapours, and about mid-day.

F. Grimaldi alſo made the ſame experiment that has been recited from Dr Hooke, in which two beams of light, entering a darkened room by two ſmall apertures near to one another, projected cones of light, which, at a certain diſtance, in part coincided; and he particularly obſerved that the dark boundaries of each of them were viſible within the lucid ground of the other.

49 Obſervation of Dechales

To theſe diſcoveries of Grimaldi, we ſhall ſubjoin an additional obſervation of Dechales; who took notice, that if ſmall ſcratches be made in any piece of poliſhed metal, and it be expoſed to the beams of the ſun in a darkened room, it will reflect the rays ſtreaked with colours in the direction of the ſcratches;

ches; as will appear if the reflected light be received upon a piece of white paper. That theſe colours are not produced by refraction, he ſays, is manifeſt; for that, if the ſcratches be made upon glaſs, the effect will be the ſame; and in this caſe, if the light had been refracted at the ſurface of the glaſs, it would have been tranſmitted through it. From theſe, and many other obſervations, he concludes that colour does not depend upon the refraction of light only, nor upon a variety of other circumſtances, which he particularly enumerates, and the effects of which he diſcuſſes, but upon the intenſity of the light only.

50 Of M. De la Hire.

We ſhall here give an account of a phenomenon of viſion obſerved by M. De la Hire, becauſe the ſubject of this ſection, viz. the *inflection of light*, ſeems to ſupply the true ſolution of it, though the author himſelf thought otherwiſe. It is obſervable, he ſays, that when we look at a candle, or any luminous body, with our eyes nearly ſhut, rays of light are extended from it, in ſeveral directions, to a conſiderable diſtance, like the tails of comets. This appearance exerciſed the ſagacity of Deſcartes and Rohault, as well as of our author; but all three ſeem to have been miſtaken with reſpect to it. Deſcartes aſcribed this effect to certain wrinkles in the ſurface of the humours of the eye. Rohault ſays, that when the eye-lids are nearly cloſed, the edges of them act like convex lenſes. But our author ſays, that the moiſture on the ſurface of the eye, adhering partly to the eye itſelf, and partly to the edge of the eye-lid, makes a concave mirror, and ſo diſperſes the rays at their entrance into the eye. But the true reaſon ſeems to be, that the light paſſing among the eye-laſhes, in this ſituation of the eye, is inflected by its near approach to them, and therefore enters the eye in a great variety of directions. The two former of theſe opinions are particularly ſtated and objected to by our author.

51 Sir Iſaac Newton's diſcoveries.

The experiments of Father Grimaldi and Dr Hooke were not only repeated with the greateſt care by Sir Iſaac Newton, but carried much farther than they had thought of. So little uſe had been made of Grimaldi's obſervations, that all philoſophers before Newton had aſcribed the broad ſhadows, and even the fringes of light which he deſcribed, to the ordinary refraction of the air; but we ſhall ſee them placed in a very different point of view by our author.

He made in a piece of lead a ſmall hole with a pin, the breadth of which was the 42d part of an inch, Through this hole he let into his darkened chamber a beam of the ſun's light; and found, that the ſhadows of hairs, and other ſlender ſubſtances placed in it, were conſiderably broader than they would have been, if the rays of light had paſſed by thoſe bodies in right lines. He therefore concluded, that they muſt have paſſed as they are repreſented in fig. 1. in which X repreſents a ſection of the hair, and AD, BE, &c. rays of light paſſing by at different diſtances, and then falling upon the wall GQ. Since, when the paper which receives the rays is at a great diſtance from the hair, the ſhadow is broad, it muſt follow, as he obſerves, that the hair acts upon the rays of light at ſome conſiderable diſtance from it, the action being ſtrongeſt on thoſe rays which are at the leaſt diſtance, and growing weaker and weaker on thoſe which are farther off, as is repreſented in this figure; and from hence it came to paſs, that the ſhadow of the hair is much broader in proportion to the diſtance of the paper from the hair when it is nearer than when it is at a great diſtance.

Plate CCVII.

He found, that it was not material whether the hair was ſurrounded with air, or with any other pellucid ſubſtance; for he wetted a poliſhed plate of glaſs, and laid the hair in the water upon the glaſs, and then laying another poliſhed plate of glaſs upon it, ſo that the water might fill up the ſpace between the glaſſes, and holding them in the beam of light, he found the ſhadow at the ſame diſtances was as big as before. Alſo the ſhadows of ſcratches made in poliſhed plates of glaſs, and the veins in the glaſs, caſt the like broad ſhadows; ſo that this breadth of ſhadow muſt proceed from ſome other cauſe than the refraction of the air.

The ſhadows of all bodies, metals, ſtones, glaſs, wood, horn, ice, &c. in this light were bordered with three parallel fringes, or bands of coloured light, of which that which was contiguous to the ſhadow was the broadeſt and moſt luminous, while that which was the moſt remote was the narroweſt, and ſo faint as not eaſily to be viſible. It was difficult to diſtinguiſh theſe colours, unleſs when the light fell very obliquely upon a ſmooth paper, or ſome other ſmooth white body, ſo as to make them appear much broader than they would otherwiſe have done; but in theſe circumſtances the colours were plainly viſible, and in the following order. The firſt or innermoſt fringe was violet, and deep blue next the ſhadow, light blue, green, and yellow in the middle, and red without. The ſecond fringe was almoſt contiguous to the firſt, and the third to the ſecond; and both were blue within, and yellow and red without; but their colours were very faint, eſpecially thoſe of the third. The colours, therefore, proceeded in the following order from the ſhadow; violet, indigo, pale blue, green, yellow, red; blue, yellow, red; pale blue, pale yellow, and red. The ſhadows made by ſcratches and bubbles in poliſhed plates of glaſs were bordered with the like fringes of coloured light.

He alſo obſerves, that by looking on the ſun thro' a feather, or black ribbon, held cloſe to the eye, ſeveral rainbows will appear, the ſhadows which the fibres or threads caſt on the retina being bordered with the like fringes of colours.

Meaſuring theſe fringes and their intervals with the greateſt accuracy, he found the former to be in the progreſſion of the numbers 1, $\sqrt{\frac{1}{3}}$, $\sqrt{\frac{1}{5}}$, and their intervals to be in the ſame progreſſion with them, that is, the fringes and their intervals together to be in continual progreſſion of the numbers 1, $\sqrt{\frac{1}{2}}$, $\sqrt{\frac{1}{3}}$, $\sqrt{\frac{1}{4}}$, $\sqrt{\frac{1}{4}}$, or thereabouts. And theſe proportions held the ſame very nearly at all diſtances from the hair, the dark intervals of the fringes being as broad in proportion to the breadth the fringes at their firſt appearance as afterwards, at great diſtances from the hair, though not ſo dark and diſtinct.

In the next obſervation of our author, we find a very remarkable and curious appearance, which we ſhould hardly have expected from the circumſtances, though it is pretty ſimilar to one that was noticed by Dr Hooke. The ſun ſhining into his darkened chamber, through a hole $\frac{1}{4}$ of an inch broad, he placed, at the diſtance of two or three feet from the hole, a ſheet of paſteboard,

board, black on both ſides; and in the middle of it he had made a hole about $\frac{1}{4}$ of an inch ſquare, for the light to paſs through; and behind the hole he faſtened to the paſteboard the blade of a ſharp knife, to intercept ſome part of the light which paſſed thro' the hole. The planes of the paſteboard and blade of the knife were parallel to one another, and perpendicular to the rays; and when they were ſo placed that none of the light fell on the paſteboard, but all of it paſſed through the hole to the knife, and there part of it fell upon the blade of the knife, and part of it paſſed by its edge, he let that part of the light which paſſed by fall on a white paper, 2 or 3 feet beyond the knife, and there ſaw two ſtreams of faint light ſhoot out both ways from the beam of light into the ſhadow, like the tails of comets. But becauſe the ſun's direct light, by its brightneſs upon the paper, obſcured theſe faint ſtreams, ſo that he could ſcarce ſee them, he made a little hole in the midſt of the paper for that light to paſs through and fall on a black cloth behind it; and then he ſaw the two ſtreams plainly. They were like one another, and pretty nearly equal in length, breadth, and quantity of light. Their light, at that end which was next to the ſun's direct light, was pretty ſtrong for the ſpace of about $\frac{1}{4}$ of an inch, or $\frac{1}{2}$ of an inch, and decreaſed gradually till it became inſenſible.

The whole length of either of theſe ſtreams, meaſured upon the paper, at the diſtance of 3 feet from the knife, was about 6 or 8 inches; ſo that it ſubtended an angle, at the edge of the knife, of about 10 or 12, or at moſt 14 degrees. Yet ſometimes he thought he ſaw it ſhoot 3 or 4 degrees farther; but with a light ſo very faint, that he could hardly perceive it. This light he ſuſpected might, in part at leaſt, ariſe from ſome other cauſe than the two ſtreams. For, placing his eye in that light, beyond the end of that ſtream which was behind the knife, and looking towards the knife, he could ſee a line of light upon its edge; and that not only when his eye was in the line of the ſtreams, but alſo when it was out of that line, either towards the point of the knife, or towards the handle. This line of light appeared contiguous to the edge of the knife, and was narrower than the light of the innermoſt fringe, and narroweſt when his eye was fartheſt from the direct light; and therefore ſeemed to paſs between the light of that fringe and the edge of the knife; and that which paſſed neareſt the edge ſeemed to be moſt bent, though not all of it.

He then placed another knife by the former, ſo that their edges might be parallel, and look towards one another, and that the beam of light might fall upon both the knives, and ſome part of it paſs between their edges. In this ſituation he obſerved, that when the diſtance of their edges was about the 400th part of an inch, the ſtream divided in the middle, and left a ſhadow between the two parts. This ſhadow was ſo black and dark, that all the light which paſſed between the knives ſeemed to be bent and turned aſide to the one hand or the other; and as the knives ſtill approached one another, the ſhadow grew broader, and the ſtreams ſhorter, next to it, till, upon the contact of the knives, all the light vaniſhed.

From this experiment our author concludes, that the light which is leaſt bent, and which goes to the inward ends of the ſtreams, paſſes by the edges of the knives at the greateſt diſtance; and this diſtance, when the ſhadow began to appear between the ſtreams, was about the 800th part of an inch; and the light which paſſed by the edges of the knives at diſtances ſtill leſs and leſs, was more and more faint, and went to thoſe parts of the ſtreams which were farther from the direct light; becauſe, when the knives approached one another till they touched, thoſe parts of the ſtreams vaniſhed laſt which were fartheſt from the direct light.

In the experiment of one knife only, the coloured fringes did not appear; but, on account of the breadth of the hole in the window, became ſo broad as to run into one another, and, by joining, to make one continual light in the beginning of the ſtreams; but in the laſt experiment, as the knives approached one another, a little before the ſhadow appeared between the two ſtreams, the fringes began to appear on the inner ends of the ſtreams, on either ſide of the direct light, three on one ſide, made by the edge of one knife, and three on the other ſide, made by the edge of the other knife. They were the moſt diſtinct when the knives were placed at the greateſt diſtance from the hole in the window, and became ſtill more diſtinct by making the hole leſs; ſo that he could ſometimes ſee a faint trace of a 4th fringe, beyond the three abovementioned; and as the knives approached one another, the fringes grew more diſtinct and larger, till they vaniſhed; the outermoſt vaniſhing firſt, and the innermoſt laſt. After they were all vaniſhed, and the line of light which was in the middle between them was grown very broad, extending itſelf on both ſides into the ſtreams of light deſcribed before, the above-mentioned ſhadow began to appear in the middle of this line, and to divide it along the middle into two lines of light, and increaſed till all the light vaniſhed. This enlargement of the fringes was ſo great, that the rays which went to the innermoſt fringe ſeemed to be bent about 20 times more when the fringe was ready to vaniſh, than when one of the knives was taken away.

From both theſe experiments compared together, our author concluded, that the light of the firſt fringe paſſed by the edge of the knife at a diſtance greater than the 800th part of an inch, that the light of the ſecond fringe paſſed by the edge of the knife at a greater diſtance than the light of the firſt fringe, and that of the third at a greater diſtance than that of the ſecond; and that the light of which the ſtreams abovementioned conſiſted, paſſed by the edges of the knives at leſs diſtances than that of any of the fringes.

He then got the edges of two knives ground truly ſtraight, and pricking their points into a board, ſo that their edges might look towards one another, and meeting near their points, contain a rectilinear angle, he faſtened their handles together, to make the angle invariable. The diſtance of the edges of the knives from one another, at the diſtance of 4 inches from the angular point, where the edges of the knives met, was the 8th part of an inch, ſo that the angle contained by their edges was about $1^{\circ}\ 54'$. The knives being thus fixed together, he placed them in a beam of the ſun's light let into his darkened chamber, thro' a hole the 42d part of an inch wide, at the diſtance of 10 or 13 feet from the hole; and he let the light which paſſed between their edges fall very obliquely on a ſmooth

ſmooth white ruler, at the diſtance of $\frac{1}{2}$ inch, or an inch, from the knives; and there he ſaw the fringes made by the two edges of the knives run along the edges of the ſhadows of the knives, in lines parallel to thoſe edges, without growing ſenſibly broader, till they meet in angles equal to the angle contained by the edges of the knives; and where they met and joined they ended, without croſſing one another. But if the ruler was held at a much greater diſtance from the knives, the fringes, where they were farther from the place of their meeting, were a little narrower, and they became ſomething broader as they approached nearer to one another, and after they met they croſſed one another, and then became much broader than before.

From theſe obſervations he concluded, that the diſtances at which the light compoſing the fringes paſſed by the knives were not increaſed or altered by the approach of the knives, but that the angles in which the rays were there bent were much increaſed by that approach, and that the knife which was neareſt to any ray determined which way the ray ſhould be bent, but that the other knife increaſed the bending.

When the rays fell very obliquely upon the ruler, at the diſtance of a third part of an inch from the knives, the dark line between the firſt and ſecond fringe of the ſhadow of one knife, and the dark line between the firſt and ſecond fringe of the ſhadow of the other knife, met one another, at the diſtance of the fifth part of an inch from the end of the light which paſſed between the knives, where their edges met one another; ſo that the diſtance of the edges of the knives, at the meeting of the dark lines, was the 160th part of an inch; and one half of that light paſſed by the edge of one knife, at a diſtance not greater than the 320th part of an inch, and, falling upon the paper, made the fringes of the ſhadow of that knife; while the other half paſſed by the edge of the other knife, at a diſtance not greater than the 320th part of an inch, and, falling upon the paper, made the fringes of the ſhadow of the other knife. But if the paper was held at a diſtance from the knives greater than the third part of an inch, the dark lines above-mentioned met at a greater diſtance than the fifth part of an inch from the end of the light which paſſed between the knives, at the meeting of their edges; ſo that the light which fell upon the paper where thoſe dark lines met paſſed between the knives, where their edges were farther diſtant than the 160th part of an inch. For at another time, when the two knives were 8 feet and 5 inches from the little hole in the window, the light which fell upon the paper where the above-mentioned dark lines met paſſed between the knives, where the diſtance between their edges was, as in the following table, at the diſtances from the paper there noted.

Diſtances of the paper from the knives in inches.	Diſtances between the edges of the knives in milleſimal parts of an inch.
$1\frac{1}{2}$	0,012
$3\frac{1}{3}$	0,020
$8\frac{3}{5}$	0,034
32	0,057
96	0,081
131	0,087

From theſe obſervations he concluded, that the light which makes the fringes upon the paper is not the ſame light at all diſtances of the paper from the knives; but that, when the paper is held near the knives, the fringes are made by light which paſſes by the edges of the knives at a leſs diſtance, and is more bent than when the paper is held at a greater diſtance from the knives.

When the fringes of the ſhadows of the knives fell perpendicularly upon the paper, at a great diſtance from the knives, they were in the form of hyperbolas, their dimenſions being as follows. Let CA, CB, repreſent lines drawn upon the paper, parallel to the edges of the knives; and between which all the light would fall if it ſuffered no inflection. DE is a right line drawn through C, making the angles ACD, BCE, equal to one another, and terminating all the light which falls upon the paper, from the point where the edges of the knives meet. Then *eis*, *fkt*, and *glv*, will be three hyperbolical lines, repreſenting the boundaries of the ſhadow of one of the knives, the dark line between the firſt and ſecond fringes of that ſhadow, and the dark line between the ſecond and third fringes of the ſame ſhadow. Alſo *xip*, *ykq*, and *zlr*, will be three other hyperbolical lines, repreſenting the boundaries of the ſhadow of the other knife, the dark line between the firſt and ſecond fringes of that ſhadow, and the dark line between the ſecond and third fringes of the ſame ſhadow. Theſe three hyperbolas are ſimilar, and equal to the former three, and croſs them in the points *i*, *k*, and *l*; ſo that the ſhadows of the knives are terminated, and diſtinguiſhed from the firſt luminous fringes, by the lines *eis* and *xip*, till the meeting and croſſing of the fringes; and then thoſe lines croſs the fringes in the form of dark lines terminating the firſt luminous fringes on the inſide, and diſtinguiſhing them from another light, which begins to appear at *i*, and illuminates all the triangular ſpace *ip* DE*s*, comprehended by theſe dark lines and the right line DE. Of theſe hyperbolas one aſymptote is the line DE, and the other aſymptotes are parallel to the lines CA and CB. Plate CCVII. fig. 2.

The ſun ſhining into his darkened room through the ſmall hole mentioned above, he placed at the hole a priſm to refract the light, and to form on the oppoſite wall the coloured image of the ſun; and he found, that the ſhadows of all bodies held in the coloured light between the priſm and the wall, were bordered with fringes of the colour of that light in which they were held; and comparing the fringes made in the ſeveral coloured lights, he found, that thoſe made in the red light were the largeſt, thoſe made in the violet were the leaſt, and thoſe made in the green were of a middle bigneſs. For the fringes with which the ſhadow of a man's hair were bordered, being meaſured croſs the ſhadow, at the diſtance of ſix inches from the hair, the diſtance between the middle and moſt luminous part of the firſt or innermoſt fringe on one ſide of the ſhadow, and that of the like fringe on the other ſide of the ſhadow, was, in the full red light $\frac{1}{37\frac{1}{2}}$ of an inch, and in the full violet $\frac{1}{46}$. The like diſtance between the middle and moſt luminous parts of the ſecond fringes, on either ſide of the ſhadow, was in the full red light $\frac{1}{22}$, and the violet $\frac{1}{27}$ of an inch; and theſe diſtances of the fringes held the ſame proportion

portion at all diſtances from the hair, without any ſenſible variation.

From theſe obſervations it was evident, that the rays which made the fringes in the red light, paſſed by the hair at a greater diſtance than thoſe which made the like fringes in the violet; ſo that the hair, in cauſing theſe fringes, acted alike upon the red light or leaſt refrangible rays at a greater diſtance, and upon the violet or moſt refrangible rays at a leſs diſtance; and thereby occaſioned fringes of different ſizes, without any change in the colour of any ſort of light.

It may therefore be concluded, that when the hair in the firſt obſervation was held in the white beam of the ſun's light, and caſt a ſhadow which was bordered with three fringes of coloured light, thoſe colours aroſe not from any new modifications impreſſed upon the rays of light by the hair, but only from the various inflections whereby the ſeveral ſorts of rays were ſeparated from one another, which before ſeparation, by the mixture of all their colours, compoſed the white beam of the ſun's light; but, when ſeparated, compoſed lights of the ſeveral colours which they are originally diſpoſed to exhibit.

52 Maraldi's diſcoveries. The perſon whoſe name we find firſt upon the liſt of thoſe who purſued any experiments ſimilar to thoſe of Newton on inflected light is M. Maraldi; whoſe obſervations chiefly reſpect the inflection of light towards other bodies, whereby their ſhadows are partially illuminated; and many of the circumſtances which he noticed relating to it are well worthy of our attention, as the reader will be convinced from the following account of them.

53 Experiments concerning the ſhadows of cylinders. He expoſed in the light of the ſun a cylinder of wood three feet long, and $6\frac{1}{2}$ lines in diameter; when its ſhadow, being received upon a paper held cloſe to it, was every where equally black and well defined, and continued to be ſo to the diſtance of 23 inches from it. At a greater diſtance the ſhadow appeared to be of two different denſities; for the two extremities of the ſhadow, in the direction of the length of the cylinder, were terminated by two dark ſtrokes, a little more than a line in breadth. Within theſe dark lines there was a faint light, equally diſperſed through the ſhadow, which formed an uniform penumbra, much lighter than the dark ſtrokes at the extremity, or than the ſhadow received near the cylinder. This appearance is repreſented in Plate CCVII. fig. 3.

As the cylinder was removed to a greater diſtance from the paper, the two black lines continued to be nearly of the ſame breadth, and the ſame degree of obſcurity; but the penumbra in the middle grew lighter, and its breadth diminiſhed, ſo that the two dark lines at the extremity of the ſhadow approached one another, till, at the diſtance of 60 inches, they coincided, and the penumbra in the middle entirely vaniſhed. At a ſtill greater diſtance a faint penumbra was viſible, but it was ill defined, and grew broader as the cylinder was removed farther off, but was ſenſible at a very great diſtance.

Beſides the black and dark ſhadow, which the cylinder formed near the opaque body, a narrow and faint penumbra was ſeen on the outſide of the dark ſhadow. And on the outſide of this there was a tract more ſtrongly illuminated than the reſt of the paper.

The breadth of the external penumbra increaſed with the diſtance of the ſhadow from the cylinder, and the breadth of the tract of light on the outſide of it was alſo enlarged; but its ſplendor diminiſhed with the diſtance.

He repeated theſe experiments with three other cylinders of different dimenſions; and from them all he inferred, that every opaque cylindrical body, expoſed to the light of the ſun, makes a ſhadow which is black and dark to the diſtance of 38 to 45 diameters of the cylinder which forms it; and that, at a greater diſtance, the middle part begins to be illuminated in the manner deſcribed above.

In explaining theſe appearances, our author ſuppoſes that the light which diluted the middle part of the ſhadow was occaſioned by the inflection of the rays, which, bending inwards on their near approach to the body, did at a certain diſtance enlighten all the ſhadow, except the edges, which was left undiſturbed. At the ſame time other rays were deflected from the body, and formed a ſtrong light on the outſide of the ſhadow, and which might at the ſame time contribute to dilute the outer ſhadow, though he ſuppoſed that penumbra to be occaſioned principally by that part of the paper not being enlightened, except by a part of the ſun's diſk only, according to the known principles of optics.

54 Concerning thoſe of globes. The ſame experiments he made with globes of ſeveral diameters; but he found, that, whereas the ſhadows of the cylinders did not diſappear but at the diſtance of 41 of their diameters, thoſe of the globes were not viſible beyond 15 of their diameters; which he thought was owing to the light being inflected on every ſide of a globe, and conſequently in ſuch a quantity as to diſperſe the ſhadows ſooner than in the caſe of the cylinders.

In all theſe caſes the penumbra occaſioned by the inflected light, began to be viſible at a leſs diſtance from the body in the ſtronger light of the ſun than in a weaker, on account of the greater quantity of rays inflected in thoſe circumſtances.

55 His miſtake concerning the moon. Conſidering the analogy between theſe experiments and the phenomena of an eclipſe of the moon, immerſed in the ſhadow of the earth, he imagined, that part of the light by which ſhe is then viſible is inflected light, and not that which is refracted by the atmoſphere; though this may be ſo copious as to efface ſeveral of the above-mentioned appearances, occaſioned by inflected light only. But this gentleman ſhould have conſidered, that as no light is inflected but what paſſes exceedingly near to any body, perhaps ſo near as the diſtance of $\frac{1}{20}$ part of an inch, this cauſe muſt be altogether inadequate to the effect.

Being ſenſible that the above-mentioned phenomena of the ſhadows were cauſed by inflected light, he was induced to give more particular attention to this remarkable property; and in order to it to repeat the experiments of Grimaldi and Sir Iſaac Newton in a darkened room. In doing this, he preſently obſerved, that, beſides the enlarged ſhadow of a hair, a fine needle, &c. the bright gleam of light that bordered it, and the three coloured rings next to this enlightened part, when the ſhadow was at a conſiderable diſtance from the hair, the dark central ſhadow was divided in the middle by a mixture of light; and that it was not of the ſame denſity, except when it was very near the hair.

This new appearance will be seen to be exactly ſimilar to what our philoſopher had obſerved with reſpect to the ſhadows in the open day-light above-mentioned; but the following obſervations, which he made with ſome variation of his apparatus, are much more curious and ſtriking, though they ariſe from the ſame cauſe.

Having placed a briſtle, which is thicker than a common hair, in the rays of the ſun, admitted into a dark chamber by a ſmall hole, at the diſtance of nine feet from the hole, it made a ſhadow, which, being received at five or ſix feet from the object, he obſerved to conſiſt of ſeveral ſtreaks of light and ſhade. The middle part was a faint ſhadow, or rather a kind of penumbra, bordered by a darker ſhadow, and after that by a narrower penumbra, next to which was a light ſtreak broader than the dark part, and next to the ſtreak of light the red, violet, and blue colours were ſeen as in the ſhadow of the hair.

In the ſame manner he placed, in the ſame rays of the ſun, ſeveral needles of different ſizes; but the appearances were ſo exceedingly various, tho' ſufficiently ſingular, that he does not recite them particularly, but chooſes rather to give, at ſome length, the obſervations he made on the ſhadows of two plates, as by that means he could better explain the phenomena of the round bodies.

56 Experiments concerning the ſhadows of metalline plates.

He expoſed in the rays of the ſun, admitted by a ſmall hole into a dark chamber, a plate that was two inches long, and a little more than half a line broad. This plate being fixed perpendicularly to the rays, at the diſtance of nine feet from the hole, a faint light was ſeen uniformly diſperſed over the ſhadow, when it was received perpendicularly to it, and very near. The ſhadow of the ſame plate being received at the diſtance of two feet and a half, was divided into four very narrow black ſtreaks, ſeparated by ſmall lighter intervals equal to them. The boundaries of this ſhadow on each ſide had a penumbra, which was terminated by a very ſtrong light, next to which were the coloured ſtreaks of red, violet, and blue, as before. This is repreſented in Plate CCVII. fig. 4.

The ſhadow of the ſame plate at $4\frac{1}{2}$ feet diſtance from it, was divided into two black ſtreaks only, the two outermoſt having diſappeared, as in fig. 5.; but theſe two black ſtreaks which remained were broader than before, and ſeparated by a lighter ſhade, twice as broad as one of the former black ſtreaks, when the ſhadow was taken at $2\frac{1}{2}$ feet. This penumbra in the middle had a tinge of red. After the two black ſtreaks there appeared a pretty ſtrong penumbra, terminated by the two ſtreaks of light, which were now broad and ſplendid, after which followed the coloured ſtreaks.

A ſecond plate, two inches long and a line broad, being placed like the former, 14 feet from the hole by which the rays of the ſun were admitted, its ſhadow being received perpendicularly very near the plate, was illuminated by a faint light, equally diſperſed, as in the the caſe of the preceding plate. But being received at the diſtance of 13 feet from the plate, ſix ſmall black ſtreaks began to be viſible, as in fig. 6. At 17 feet from the plate, the black ſtreaks were broader, more diſtinct, and more ſeparated from the ſtreaks that were leſs dark. At 42 feet from the plate, only two black ſtreaks were ſeen in the middle of the penumbra, as in fig. 7. This middle penumbra between the two black ſtreaks was tinged with red. Next to the black ſtreaks there always appeared the ſtreaks of light, which were broad, and the coloured ſtreaks next to them.

Receiving the ſhadow of the ſame plate at the diſtance of 72 feet, the appearances were the ſame as in the former ſituation, except that the two black ſtreaks were broader, and the interval between them, occupied by the penumbra, was broader alſo, and tinged with a deeper red.

In the ſame rays of the ſun he placed different plates, and larger than the former, one of them a line and a half, another two lines, another three lines broad, &c. but receiving their ſhadows upon paper, he could not perceive in them thoſe ſtreaks of faint light which he had obſerved in the ſhadows of the ſmall plates, though he received theſe ſhadows at the diſtance of 56 feet. Nothing was ſeen but a weak light, equally diffuſed, as in the ſhadows of the two ſmalleſt plates, received very near them. But had his dark chamber been large enough, he did not doubt, but that, at a proper diſtance, there would have been the ſame appearances in the ſhadows of the larger plates as in thoſe of the ſmalleſt. For the ſame reaſon, he ſuppoſed, that, if the ſhadows of the ſmall needles could have been diſtinctly viewed very near thoſe bodies, the different ſtreaks of light and ſhade would have been as viſible in them as in thoſe of the ſmall plates; and indeed he did obſerve the ſame appearances in the ſhadows of needles of a middling ſize.

The ſtreaks of light in theſe ſhadows our author aſcribed to the rays of light which are inflected at different diſtances from the bodies; and he imagined that their croſſing one another was ſufficient to account for the variations obſervable in them at different diſtances.

The extraordinary ſize of the ſhadows of theſe ſmall ſubſtances M. Maraldi thought to be occaſioned by the ſhadow from the enlightened part of the ſky, added to that which was made by the light of the ſun, and alſo to a vortex occaſioned by the circulation of the inflected light behind the object; but our readers will probably not think it neceſſary for us either to produce all his reaſons for this hypotheſis, or to enter into a refutation of them.

Our author having made the preceding experiments upon ſingle long ſubſtances, had the curioſity to place two of them ſo as to croſs one another in a beam of the ſun's light. The ſhadows of two hairs placed in this manner, and received at ſome diſtance from them, appeared to be painted reciprocally one upon the other, ſo that the obſcure part of one of them was viſible upon the obſcure part of the other. The ſtreaks of light alſo croſſed one another, and the coloured ſtreaks did the ſame.

Having placed a needle and a hair croſſing one another, their ſhadows, at the ſame diſtance, exhibited the ſame appearances as the ſhadows of the two hairs, though the ſhadow of the needle was the ſtronger.

He alſo placed in the rays of the ſun a briſtle and a plate of iron a line thick, ſo that they croſſed one another

another obliquely; and when their ſhadows were received at the ſame diſtance, the light and dark ſtreaks of the ſhadow of the briſtle were viſible ſo far as the middle of the ſhadow of the plate on the ſide of the acute angle, but not on the ſide of the obtuſe angle, whether the briſtle or the plate were placed next to the rays. The plate made a ſhadow ſufficiently dark, divided into ſix black ſtreaks; and theſe were again divided by as many light ones equal to them; and yet all the ſtreaks belonging to the ſhadow of the briſtles were viſible upon it, as in fig. 8. To explain this appearance, he ſuppoſed that the rays of the ſun glid a little along the briſtle, ſo as to enlighten part of that which is behind the plate. But this ſeems to be an arbitrary and improbable ſuppoſition.

Our philoſopher did not fail to expoſe ſeveral ſmall globes in the light of the ſun in his dark chamber, and to compare their ſhadows with thoſe of the long ſubſtances, as he had done in the day-light, and the appearances were ſtill ſimilar. It was particularly evident, that there was much more light in the ſhadows of the globes than in thoſe of the cylinders, not only when they were both of an equal diameter, but when that of the globe was larger than that of the cylinder, and the ſhadows of both the bodies were received at the ſame diſtance. He alſo obſerved, that he could perceive no difference of light in the ſhadows of the plates which were a little more than one line broad, though they were received at the diſtance of 72 feet; but he could eaſily ſee a difference of ſhades in thoſe of the globes, taken at the ſame diſtance, tho' they were $2\frac{1}{4}$ lines in diameter.

In order to explain the colours at the edges of theſe ſhadows, he contrived to throw ſome of the ſhadows upon others; and the following obſervations, though they did not enable him to accompliſh what he intended, are curious and worth reciting.

57 Experiments with a mixture of coloured ſhadows.

Having thrown ſeveral of the ſimilar colours upon one another, and thereby produced a tinge more lively than before, he threw the gleam of light, which always intervened between the colours and the darker part of the ſhadow, upon different parts of other ſhadows; and obſerved, that, when it fell upon the exterior penumbra made by another needle, it produced a beautiful ſky-blue colour, almoſt like that which was produced by two blue colours thrown together. When the ſame gleam of light fell upon the deeper ſhadow in the middle, it produced a red colour; which ſeemed to prove, that the reddiſh colour in the middle of ſeveral of the ſhadows might come from the little light inflected into that place. But here our author ſeems to have been miſled by ſome falſe hypotheſis concerning colours.

He placed two plates of iron, each three or four lines broad, very near one another, but with a very ſmall interval between them; and having placed them in the rays of the ſun, and received their ſhadows at the diſtance of 15 or 20 feet from them, he ſaw no light between them but a continued ſhadow, in the middle of which were ſome ſtreaks of a lively purple, parallel to one another, and ſeparated by other black ſtreaks; but between them there were other ſtreaks, both of a very faint green, and alſo of a pale yellow. He alſo informs us, that M. Deliſle had obſerved colours in the ſtreaks of light and ſhade, which are obſervable in ſhadows taken near the bodies.

58 M. Mairan's obſervations.

Among thoſe who followed Sir Iſaac Newton in his obſervations on the inflection of light, we alſo find the ingenious M. Mairan: but, without attempting the diſcovery of new facts, he only endeavoured to explain the old ones, by the hypotheſis of an atmoſphere ſurrounding all bodies; and conſequently making two reflections and refractions of the light that impinges upon them, one at the ſurface of the atmoſphere, and the other at that of the body itſelf. This atmoſphere he ſuppoſed to be of a variable denſity and refractive power, like the air.

59 Diſcoveries of M. Du Tour.

M. Mairan was ſucceeded by M. Du Tour, who thought the variable atmoſphere ſuperfluous, and imagined that he could account for all the phenomena by the help of an atmoſphere of an uniform denſity, and of a leſs refractive power than the air ſurrounding all bodies. But what we are moſt obliged to this gentleman for is, not his ingenious *hypotheſis*, but the beautiful variety with which he has exhibited the *experiments*, which will render it much eaſier for any perſon to inveſtigate the true cauſes of them.

Before M. Du Tour gave his attention to this ſubject, only three fringes had been obſerved in the colours produced by the inflection of light; but he was accidentally led to obſerve a greater number of them, and hit upon the following ingenious method of making them all appear very diſtinct.

Plate CCVII.

He took a circular board ABED (fig. 9.), 13 inches in diameter, the ſurface of which was black, except at the edge, where there was a ring of white paper about three lines broad, in order to trace the circumference of a circle, divided into 360 degrees, beginning at the point A, and reckoning 180 degrees on each hand to the point E; B and D being each of them placed at 90 degrees. A ſlip of parchment three inches broad, and diſpoſed in the form of a hoop, was faſtened round the board, and pierced at the point E with a ſquare hole, each ſide being four or five lines, in order to introduce a ray of the ſun's light. Laſtly, in the centre of the board C, and perpendicular to it, he fixed a pin about $\frac{1}{3}$ of a line in diameter.

This hoop being ſo diſpoſed, that a ray of light entering the dark chamber, through a vertical cleft of two lines and a half in length, and about as wide as the diameter of the pin, went through the hole at E, and paſſing parallel to the plane of the board, projected the image of the ſun and the ſhadow of the pin at A. In theſe circumſtances he obſerved,

1. That quite round the concave ſurface of this hoop, there were a multitude of coloured ſtreaks; but that the ſpace *m* A *n*, of about 18 degrees, the middle of which was occupied by the image of the ſun, was covered with a faint light only.

2. The order of the colours in theſe ſtreaks was generally ſuch that the moſt refrangible rays were the neareſt to the incident ray ECA; ſo that, beginning from the point A, the violet was the firſt, and the red the laſt colour in each of the ſtreaks. In ſome of them, however, the colours were diſpoſed in a contrary order.

3. The image of the ſun, projected on each ſide of the point A, was divided by the ſhadow of the pin, which was bordered by two luminous ſtreaks.

4. The coloured ſtreaks were narrower in ſome parts of the hoop than others, and generally decreaſed in breadth in receding from the point A.

5. Among theſe coloured ſtreaks, there were ſometimes others which were white, a line or a line and an half in breadth, which were always bordered on both ſides by a ſtreak of orange colour, at leaſt when the light of the ſun was intenſe, and the chamber ſufficiently dark.

From this experiment he thought it was evident, that the rays which paſſed beyond the pin were not the only ones that were decompoſed, for that thoſe which are reflected back from the pin were decompoſed alſo; from which he concluded, that they muſt have undergone ſome refraction. He alſo thought that thoſe which went beyond the pin ſuffered a reflection, ſo that they were all affected in a ſimilar manner.

In order to account for theſe facts, our author deſcribes the progreſs of a ray of light through an uniform atmoſphere, which he ſuppoſes to ſurround the pin; and ſhews, that the differently refrangible rays will be ſeparated at their emergence from it: but he refers to ſome experiments and obſervations in a future memoir, to demonſtrate that all the coloured ſtreaks are produced by rays that are both reflected and refracted.

Plate CCVII. 60 Account of Du Tour's hypotheſis.

To give ſome idea of his hypotheſis, he ſhews that the ray *a b*, fig. 10. after being refracted at *b*, reflected at *r* and *u*, and again refracted at *s* and *t*, will be divided into its proper colours; the leaſt refrangible or the red rays iſſuing at *x*, and the moſt refrangible or violet at *y*; which agrees with his obſervations. Thoſe ſtreaks in which the colours appear in a contrary order he thinks are to be aſcribed to inequalities in the ſurface of the pin. This might eaſily have been aſcertained by turning the pin round, in which caſe theſe differently-coloured ſtreaks would have changed their places.

If any perſon ſhould chooſe to repeat theſe experiments, he obſerves that it requires that the ſky be very clear and free from vapours, in order to exhibit the colours with the greateſt diſtinctneſs; ſince even the vapours that are imperceptible, will diminiſh the luſtre of the colours on every part of the hoop, and even efface ſome of them, eſpecially thoſe which are on that in which the beam of light enters, as at E, where the colours are always fainter than in any other place, and indeed can never be diſtinguiſhed except when the hole E is confined by black ſubſtances, ſo as to intercept a part of the light that might reach the pin; and unleſs alſo thoſe rays which go beyond the pin to form the image of the ſun at A be ſtopped, ſo that no rays are viſible except thoſe that are reflected towards the hole, and which make the faint ſtreaks.

The coloured ſtreaks that are next the ſhadow of the pin, he ſhews, are formed by thoſe rays which, entering the atmoſphere, do not fall upon the pin; and, without any reflection, are only refracted at their entering and leaving the atmoſphere, as at *b* and *r u*, fig. 11. In this caſe, the red or leaſt refrangible rays will iſſue at *r*, and the violet at *u*.

To diſtinguiſh the rays which fell upon the hoop in any particular direction, from thoſe that came in any other, he made an opening in the hoop, as at P, by which means he could, with advantage, and at any diſtance from the centre, obſerve thoſe rays unmixed with any other.

To account for the coloured ſtreaks being larger next the ſhadow of the pin, and growing narrower to the place where the light was admitted, he ſhews, by fig. 12. that the rays *a b* are farther ſeparated by both the refractions than the rays *c d*.

Sometimes our author obſerved, that the broader ſtreaks were not diſpoſed in this regular order; but then he found, that, by turning the pin, they changed their places, ſo that this circumſtance muſt have been an irregularity depending upon the accidental ſurface of the pin.

The white ſtreaks intermixed with the coloured ones he aſcribes to ſmall cavities in the ſurface of the pin, or ſome other foreign circumſtance; for they alſo changed their places when the pin was made to turn upon its axis.

Other obſervations of our author ſeem to prove that the refracting atmoſpheres ſurrounding all kinds of bodies are of the ſame ſize; for when he placed a great variety of ſubſtances, and of different ſizes alſo, he always found the coloured ſtreaks of the ſame dimenſions.

M. Du Tour obſerves that his hypotheſis contradicts an obſervation of Sir Iſaac Newton, that thoſe rays which paſs the neareſt to any body are the moſt inflected; but he thinks that Newton's obſervations were not ſufficiently accurate. Beſides, he obſerves, that Newton only ſaid that *he thought it to be ſo*, without aſſerting it poſitively.

Since the rays which formed theſe coloured ſtreaks are but little diverted out of their way, our author infers that this atmoſphere is of ſmall extent, and that its refractive power is not much leſs than that of air.

Expoſing two pieces of paper in the beam of light, ſo that part of it paſſed between two planes formed by them, M. Du Tour obſerved, that the edges of this light, received upon paper, were bordered with two orange-coloured ſtreaks, which Newton had not taken notice of in any of his experiments. To account for them, he ſuppoſes, that in fig. 13. the more refrangible of the rays which enter at *b* are ſo refracted, that they do not reach the ſurface of the body itſelf at R; ſo that the red and orange-coloured light may be reflected from thence in the direction *d* M, where the orange-coloured ſtreaks will be formed; and, for the ſame reaſon, another ſtreak of orange will be formed at *m*, by the rays which enter the atmoſphere on the other ſide of the chink. In a ſimilar manner he accounts for the orange-coloured fringes at the borders of the white ſtreaks, in the experiment of the hoop.

The blue rays, which are not reflected at R, he ſuppoſes paſs on to I, and that of theſe rays the blue tinge obſervable in the ſhadows of ſome bodies are formed.

61 Objects ſometimes magnified by the inflection of light.

M. Le Cat has well explained a phenomenon of viſion depending upon the inflection of light, which ſhews, that, in ſome caſes, objects appear magnified by this means. Looking at a diſtant ſteeple, when a wire, of a leſs diameter than the pupil of his eye, was held pretty near to it, and drawing it ſeveral times betwixt

betwixt his eye and that object, he was furprifed to find, that, every time the wire paffed before his pupil, the fteeple feemed to change its place, and fome hills beyond the fteeple feemed to have the fame motion, juft as if a lens had been drawn betwixt his eye and them.

Examining this appearance more attentively, he found that there was a pofition of the wire, but very difficult to keep, in which the fteeple feemed not to have any motion, when the wire was paffed before his eye; and in this cafe the fteeple appeared lefs diftinctly, and feemed to be magnified. Thefe effects being fimilar to thofe of a lens, he attended to them more particularly; and placed his eye in fuch a manner, with refpect to the fteeple, that the rays of light by which he faw it muft come very clofe to the edge of a window, where he had placed himfelf to make his obfervations. Then paffing the wire once more before his eye, he obferved, that, when it was in the vifual axis, the fteeple appeared nearer to the window, on whichever fide the wire was made to approach. He repeated this experiment, and conftantly with the fame refult, the object being always magnified, and nearly doubled, by this means.

This phenomenon is eafily explained by fig. 14. in which B reprefents the eye, A the fteeple, and C the diameter of the wire. The black lines exprefs the cone of light by which the natural image of the fteeple A is formed, and which is much narrower than the diameter of the wire C; but the dotted lines include not only that cone of light, ftopped and turned out of its courfe by the wire, but alfo more diftant rays inflected by the wire, and thereby thrown more converging into the pupil; juft as would have been the effect of the interpofition of a lens between the eye and the object. The refult of this experiment was the fame, whatever fubftances he made ufe of in the place of the wire, provided they were of the fame diameter.

62 Mifcellaneous obfervations.

This difcovery, depending upon the inflection of the rays of light, led him to feveral others depending upon the fame principle. Thus he magnified fmall objects, as the head of a pin, by looking at them through a fmall hole in a card; fo that the rays which formed the image muft neceffarily pafs fo near the circumference of the hole, as to be attracted by it. He alfo obferved, that, by bringing his finger near the cone of light, which tranfmitted to him the image of any object well infulated, as a red coal in the midft of cinders, or a black coal in the midft of the fire, the object feemed to ftretch itfelf towards his finger, as it approached, and to follow it to a certain diftance when it was withdrawn. He thought it was owing to the fame caufe, that the clouds which pafs over the face of the fun occafion various motions in the fhadow of bodies; and when thefe clouds are interrupted in different places, thofe fhadows feems to dance, which is particularly vifible in the fhadows made by the leads in glafs-windows. It was to the fame inflection of light that he afcribed, in part, the prifmatic colours which he faw by the means of a very fine pin, placed near to his eye, and on which he made the light of a candle to fall obliquely.

§ 5. *Difcoveries concerning Vifion.*

Maurolycus was the firft who fhewed the true theory of vifion, by demonftrating that the cryftalline humour of the eye is a lens which collects the light iffuing from external objects, and throws them upon the retina, where is the focus of each pencil. He did not, however, find out, that, by means of this refraction of the rays, an image of every vifible object was formed upon the retina, though this feems hardly to have been a ftep beyond the difcovery he had already made. Montucla conjectures, that he was prevented from coming to this difficulty of accounting for the upright appearance of objects, as this image is always inverted. This difcovery was made by Kepler; but he, too, was much difficulted with the inverted pofition of the image. The rectification of thefe images, he fays, is the bufinefs of the mind; which, when it perceives an impreffion on the lower part of the retina, confiders it as made by rays proceeding from the higher parts of objects; tracing the rays back to the pupil, where they crofs one another. But this hypothefis can fcarcely be deemed fatisfactory.—Kepler did not pretend to account for the manner in which the mind perceives the images upon the retina, and very much blames Vitellio for attempting prematurely to determine a queftion of this nature, and which indeed, he fays, does not belong to optics. He accounts, however, though not in a fatisfactory manner, for the power we have of feeing diftinctly at different diftances.

63 Difcoveries of Maurolycus, Kepler, &c. concerning vifion.

64 Difcoveries of Scheiner.

The difcovery concerning vifion was completed by Scheiner. For, in cutting away the coats of the back part of the eyes of fheep and oxen, and prefenting feveral objects before them, within the ufual diftance of vifion, he faw their images diftinctly and beautifully painted upon the retina. He did the fame thing with the human eye, and exhibited this curious experiment at Rome in 1625. He takes particular notice of the refemblance between the eye and the camera obfcura, and explains a variety of methods to make the images of objects erect. As to the images of objects being inverted in the eye, he acquiefces in the reafon given for it by Kepler. He knew that the pupil of the eye is enlarged in order to view remote objects, and that it is contracted while we are viewing thofe that are near; and this he proved by experiment, and illuftrated by figures.

Scheiner alfo took a good deal of pains to afcertain the denfity and refractive power of all the humours of the eye by comparing their magnifying power with that of water or glafs in the fame form and circumftances. The refult of his inquiries was, that the aqueous humour doth not differ much from water in this refpect, nor the cryftalline from glafs; and that the vitreous humour is a medium between both. He alfo very accurately and minutely traces the progrefs of the rays of light through all the humours of the eye, and after difcuffing every poffible hypothefis concerning the proper feat of vifion, he demonftrates that it is in the retina, and fhews that this was the opinion of Alhazen, Vitellio, Kepler, and all the moft eminent philofophers. He produces many reafons of his own for this hypothefis; anfwers a great number of objections to it; and, by a variety of arguments, refutes the opinion of former times, that the feat of vifion is in the cryftalline.

Defcartes makes a good number of obfervations on the

65 Discoveries of Descartes.

the phenomena of vision. He explains satisfactorily the natural methods of judging of the magnitudes, situations and distances, of objects by the direction of the optic axes; comparing it to a blind man's judging of the size and distance of an object, by feeling at it with two sticks of a known length, when the hands in which he holds them are at a known distance from each other. He also observes, that having been accustomed to judge of the situation of objects by their images falling on a particular part of the eye; if by any distortion of the eye they fall on a different place, we are apt to mistake their situation, or imagine one object to be two; as, till we become accustomed to it, we imagine one stick to be two, when it is placed between two contiguous fingers laid across one another. But he observes, that all the methods we have of judging of the distances of objects are very uncertain, and extend but to narrow limits. The direction of the optic axes, he says, will not serve us beyond 15 or 20 feet, and the change of form of the crystalline not more than three or four feet. For he imagined that the eye conforms itself to the view of near or distant objects by a change in the curvature of the crystalline, which he supposed to be a muscle, the tendons of it being the processus ciliares. In another place, he says, that the change in the conformation of the eye is of no use to us for the purpose of judging of distances beyond four or five feet, and the angle of the optic axes not more than 100 or 200 feet. For this reason, he says, that the sun and moon are conceived to be much more nearly of the same size than they are in reality. White and luminous objects, he says, appear larger than others, and also the parts contiguous to those on which the rays actually impinge; and for the same reason, if the objects be small, and placed at a great distance, they will always appear round, the figure of the angles disappearing. The description of the eye itself, the various modes of vision and optical deceptions to which we are liable, belong properly to the succeeding part of this treatise.

§ 6. *Of Optical Instruments, and Discoveries concerning them.*

66 Invention of spectacles.

So little were the ancients acquainted with the science of Optics, that they seem to have have had no instruments of the optical kind, excepting the glass globes and speculums formerly mentioned, which they used in some cases for magnifying and burning. Alhazen, as we have seen, gave the first hint of the invention of spectacles, and it is probable that they were found out soon after his time. From the writings of Alhazen and the observations and experiments of Bacon together, it is not improbable that some monks gradually hit upon the construction of spectacles; to which Bacon's lesser segment, notwithstanding his mistake concerning it, was a nearer approach than Alhazen's larger one. Whoever they were that pursued the discoveries of Bacon, they probably observed, that a very small convex glass, when held at a greater distance from the book, would magnify the letters more than when it was placed close to them, in which position only Bacon seems to have used it. In the next place, they might try whether two of these small segments of a sphere placed together, or a glass convex on both sides, would not magnify more than one of them. They would then find, that two of these glasses, one for each eye, would answer the purpose of reading better than one; and lastly they might find, that different degrees of convexity suited different persons.

It is certain that spectacles were well known in the 13th century, and not long before. It is said that Alexander Spina, a native of Pisa, who died in 1313, and who was very ingenious in executing whatever he saw or heard of as having been done by others, happened to see a pair of spectacles in the hands of a person who would not explain them to him; but that he succeeded in making a pair for himself, and immediately made the construction public, for the good of others. It is also inscribed on the tomb of Salvinus Armatus, a nobleman of Florence, who died 1317, that he was the inventor of spectacles.

67 Of concave glasses.

The use of concave glasses, to help those persons who are short-sighted, was, probably, a discovery that did not follow long after that of convex ones, for the relief of those whose sight is defective in the contrary extreme, though we find no trace of this improvement. Whoever made this discovery, it was probably the result of nothing more than a random experiment. Perhaps a person who was short-sighted, finding that convex glasses did him more harm than good, had the curiosity to make trial of a contrary curvature of the glass.

68 Descartes's account of the invention of telescopes.

From this time, though both convex and concave lenses were sufficiently common, yet no attempt was made to form a telescope by a combination of them, till the end of the 16th century. Descartes considers James Metius, a person who was no mathematician, though his father and brother had applied to those sciences, as the first constructor of a telescope; and says, that as he was amusing himself with making mirrors and burning-glasses, he casually thought of looking thro' two of his lenses at a time; and that happening to take one that was convex and another that was concave, and happening also to hit upon a pretty good adjustment of them, he found, that, by looking thro' them, distant objects appeared very large and distinct. In fact, without knowing it, he had made a telescope.

69 Other accounts.

Other persons say, that this great discovery was first made by John Lippersheim, a maker of spectacles at Middleburgh, or rather by his children; who, like, Metius, were diverting themselves with looking thro' two glasses at a time, and placing them at different distances from one another. But Borellus, the author of a book intitled, *De vero telescopii inventore*, gives this honour to Zacharias Joannides, i. e. Jansen, another maker of spectacles at the same place, who made the first telescope in 1590; and it seems now to be the general opinion, that this account of Borellus is the most probable.

70 Borellus's account probably the true one.

Indeed, Borellus's account of the discovery of telescopes is so circumstantial, and so well authenticated, that it does not seem possible to call it in question. It is not true, he says, that this great discovery was made by a person who was no philosopher: for Zacharias Jansen was a diligent inquirer into nature; and being engaged in these pursuits, he was trying what uses could be made of lenses for those purposes, when he

he fortunately hit upon the conſtruction.

This ingenious mechanic, or rather philoſopher, had no ſooner found the arrangement of glaſſes that produced the effect he deſired, than he incloſed them in a tube, and ran with his inſtrument to prince Maurice; who immediately conceiving that it might be of uſe to him in his wars, deſired the author to keep it a ſecret. But this, though attempted for ſome time, was found to be impoſſible; and ſeveral perſons in that city immediately applied themſelves to the making and ſelling of teleſcopes. One of the moſt diſtinguiſhed of theſe was Hans Laprey, called *Lipperſheim* by Sirturus. By him ſome perſon in Holland being very early ſupplied with a teleſcope, he paſſed with many for the inventor; but both Metius above-mentioned, and Cornelius Drebell of Alcmar, in Holland, applied to the inventor himſelf in 1620; as alſo did Galileo, and many others. The firſt teleſcope made by Janſen did not exceed 15 or 16 inches in length; but Sirturus, who ſays that he had ſeen it, and made uſe of it, thought it the beſt that he had ever examined.

71 The firſt teleſcope an exceedingly good one.

Janſen, having a philoſophical turn, preſently applied his inſtrument to ſuch purpoſes as he had in view when he hit upon the conſtruction. Directing it towards celeſtial objects, he diſtinctly viewed the ſpots on the ſurface of the moon; and diſcovered many new ſtars, particularly ſeven pretty conſiderable ones in the great bear. His ſon Joannes Zachariæ, noted the lucid circle near the limb of the moon, from whence ſeveral bright rays ſeem to dart in different directions; and he ſays, that the full moon viewed through this inſtrument, did not appear flat, but was evidently ſpherical, the middle part being prominent. Jupiter alſo, he ſays, appeared round, and rather ſpherical; and ſometimes he perceived two, ſometimes three, and at the moſt four ſmall ſtars, a little above or below him; and as far as he could obſerve, they performed revolutions round him; but this, he ſays, he leaves to the conſideration of aſtronomers. This, it is probable, was the firſt obſervation of the ſatellites of Jupiter, tho' the perſon who made it was not aware of the importance of his diſcovery.

72 Honour of the invention claimed by Fontana.

One Francis Fontana, an Italian, alſo claims the invention; but as he did not pretend to have made it before the year 1608, and as it is well known that the inſtruments were made and ſold in Holland ſome time before, his pretenſions to a ſecond diſcovery are not much regarded.

73 A teleſcope made by Galileo without ſeeing one.

There are ſome, who ſay that Galileo was the inventor of teleſcopes; but he himſelf acknowledges, that he firſt heard of the inſtrument from a German; but he ſays, that being informed of nothing more than the effects of it, firſt by common report, and a few days after by a French nobleman, J. Badovere, at Paris, he himſelf diſcovered the conſtruction, by conſidering the nature of refraction: and thus he had much more real merit than the inventor himſelf.

The account of what Galileo actually did in this buſineſs, is ſo circumſtantially related by the author of his life, prefixed to the quarto edition of his works, printed at Venice in 1744, and it contains ſo many particulars, which cannot but be pleaſing to every perſon who is intereſted in the hiſtory of teleſcopes, that we ſhall abridge a part of it, intermixing circumſtances collected from other accounts.

74 Account of his diſcoveries.

About April or May, in 1609, it was reported at Venice, where Galileo (who was profeſſor of mathematics in the univerſity of Padua) then happened to be, that a Dutchman had preſented to Count Maurice of Naſſau, a certain optical inſtrument, by means of which, diſtant objects appeared as if they were near; but no farther account of the diſcovery had reached that place, tho' this was near 20 years after the firſt diſcovery. Struck, however, with this account, Galileo inſtantly returned to Padua, conſidering what kind of an inſtrument this muſt be. The night following, the conſtruction occurred to him; and the day after, putting the parts of the inſtrument together, as he had previouſly conceived of it, and, notwithſtanding the imperfection of the glaſſes that he could then procure, the effect anſwered his expectations, as he preſently acquainted his friends at Venice; to which place, he ſix days afterwards carried another and a better inſtrument that he had made, and where, from ſeveral eminences, he ſhewed to ſome of the principal ſenators of that republic a variety of diſtant objects, to their very great aſtoniſhment. When he had made farther improvements in the inſtrument, he, with his uſual generoſity and frankneſs in communicating his diſcoveries, made a preſent of one of them to the Doge, Leonardo Donati, and at the ſame time to all the ſenate of Venice; giving along with the inſtrument, a written paper, in which he explained the ſtructure and wonderful uſes that might be made of it both by land and at ſea. In return for ſo noble an entertainment, the republic, on the 25th of Auguſt, in the ſame year, more than tripled his ſalary as profeſſor.

Our philoſopher, having amuſed himſelf for ſome time with the view of terreſtrial objects, at length directed his tube towards the heavens; and, obſerving the moon, he found, that the ſurface of it was diverſified with hills and valleys, like the earth. He found that the *via lactea* and *nebulæ* conſiſted of a collection of fixed ſtars, which, on account either of their vaſt diſtance, or extreme ſmallneſs, were inviſible to the naked eye. He alſo diſcovered innumerable fixed ſtars diſperſed over the face of the heavens, which had been unknown to all the ancients; and examining Jupiter, with a better inſtrument than any he had made before, he found that he was accompanied by four ſtars, which, in certain fixed periods, performed revolutions round him, and which, in honour of the houſe of Medici, he called *Medicean planets*.

This diſcovery he made in January 1610, new ſtyle; and continuing his obſervations the whole of February following, in the beginning of March next he publiſhed an account of all his diſcoveries, in his *Nuncius Sidereus*, printed at Venice, and dedicated to Coſimo, great duke of Tuſcany, who, by a letter which he wrote to him on the 10th of July 1610, invited him to quit Padua, and aſſigned him an ample ſtipend, as primate and extraordinary profeſſor at Piſa, but without any obligation to read lectures, or to reſide.

The extraordinary diſcoveries contained in the Nuncius Sidereus, which was immediately reprinted both in Germany and France, was the cauſe of much ſpeculation and debate among the philoſophers and aſtronomer's of that time; many of whom could not be brought

brought to give any credit to Galileo's account, while others endeavoured to decry his discoveries as being nothing more than fictions or illusions. Some could not be prevailed upon even to look through a telescope; so devoted were they to the system of Aristotle, and so averse to admit any other source of knowledge besides his writings. When it was found to be in vain to oppose the evidence of sense, some did not scruple to assert that the invention was taken from Aristotle; and producing a passage from his writings, in which he attempts to give a reason why stars are seen in the day-time from the bottom of a deep well, said, that the well corresponded to the tube of the telescope, and that the vapours which arose from it gave the hint of putting glasses into it; and lastly, that in both cases the sight is strengthened by the transmission of the rays through a thick and dark medium. Galileo himself tells this story with a great deal of humour; comparing such men to alchymists, who imagine that the art of making gold was known to the ancients, but lay concealed under the fables of the poets.

In the beginning of July of the same year, 1610, Galileo being still at Padua, and getting an imperfect view of Saturn's ring, imagined that that planet consisted of three parts; and therefore, in the account which he gave of this discovery to his friends, he calls it *planetam tergeminum*.

Whilst he was still at Padua, which must have been either in the same month of July, or the beginning of August following, he observed some spots on the face of the sun: but, contrary to his usual custom, he did not choose, at that time, to publish his discovery; partly for fear of incurring more of the hatred of many obstinate peripatetics; and partly, in order to make more exact observations on this remarkable phenomenon, and to form some conjecture concerning the probable cause of it. He therefore contented himself with communicating his observations to some of his friends at Padua and Venice, among whom we find the name of father Paul. This delay, however, was the cause of this discovery being contested with him by the famous Scheiner, who likewise made the same observation in Oct. 1611, and we suppose had anticipated Galileo in the publication of it.

About the end of August, Galileo left Padua and went to Florence; and in November following he was satisfied, that, from the September preceding, Venus had been continually increasing in bulk, and that she changed her phases like the moon. About the end of March 1611, Galileo went to Rome, where he gratified the cardinals, and all the principal nobility, with a view of the new wonders he had discovered in the heavens, and among others the solar spots.

75 Named *Lynceus* from them.

From these discoveries Galileo obtained the name of *Lynceus*, who was famous in antiquity for the acuteness of his sight; and moreover, the marquis of Monticelli instituted an academy, with the title of *De' Lincei*, and made him a member of it. Twenty-nine years Galileo enjoyed the use of his telescope, continually enriching astronomy with his observations: but by too close an application to that instrument, and the detriment he received from the nocturnal air, his eyes grew gradually weaker, till in 1639 he became totally blind; a calamity which, however, neither broke his spirits, nor interrupted the course of his studies.

The first telescope that Galileo constructed magnified only three times: but presently after, he made another which magnified 18 times: and afterwards, with great trouble and expence, he constructed one that magnified 33 times; and with this it was that he discovered the satellites of Jupiter, and the spots of the sun. 76 Account of his telescopes.

Notwithstanding Galileo must be allowed to have considerable merit with respect to telescopes, it was neither that of the person who first hit upon the construction, nor that of him who thoroughly explained the *rationale* of the instrument. This important service to science was performed by John Kepler, whose name is famous on many accounts in the annals of philosophy, and especially by his discovery of the great law of motion respecting the heavenly bodies; which is, that the squares of their periodical times are as the cubes of their distances from the body about which they revolve; a proposition which, however, was not demonstrated before Sir Isaac Newton. Kepler was astronomer to several of the emperors of Germany; he was the associate of the celebrated astronomer Tycho Brahe, and the master of Descartes.

77 The rationale of the instrument first discovered by Kepler.

Kepler made several discoveries relating to the nature of vision; and not only explained the rationale of the telescope which he found in use, but also pointed out methods of constructing others of superior powers and more commodious application.

It was Kepler who first gave a clear explication of the effects of lenses, in making the rays of a pencil of light converge or diverge. He shewed, that a plano-convex lens makes rays that were parallel to its axis, to meet at the distance of the diameter of the sphere of convexity; but that if both sides of the lens be equally convex, the rays will have their focus at the distance of the radius of the circle, corresponding to that degree of convexity. But he did not investigate any rule for the foci of lenses unequally convex. He only says, in general, that they will fall somewhere in the medium, between the foci belonging to the two different degrees of convexity. It is to Cavallieri that we owe this investigation. He laid down this rule: As the sum of both the diameters is to one of them, so is the other to the distance of the focus. All these rules concerning convex lenses are applicable to those that are concave; with this difference, that the focus is on the contrary side of the glass, as will be particularly shewn in the second part of this treatise.

78 General reason of the effects of telescopes.

The principal effects of telescopes depend upon these plain maxims, *viz.* That objects appear larger in proportion to the angles which they subtend at the eye; and the effect is the same whether the pencils of rays, by which objects are visible to us, come directly from the objects themselves, or from any place nearer to the eye, where they may have been united so as to form an image of the object; because they issue again from those points where there is no real substance, in certain directions, in the same manner as they did from the corresponding points in the objects themselves.

In fact, therefore, all that is effected by a telescope is, first to make such an image of a distant object, by means of a lens or mirror; and then to give the eye some assistance for viewing that image as near as possible; so that the angle which it shall subtend at the eye, may be very large compared with the angle which the

the object itself would subtend in the same situation. This is done by means of an eye-glass, which so refracts the pencils of rays, as that they may afterwards be brought to their several foci by the natural humours of the eye. But if the eye was so formed as to be able to see the image with sufficient distinctness at the same distance without any eye-glass, it would appear to him as much magnified as it does to another person who makes use of a glass for that purpose, though he would not in all cases have so large a field of view.

If, instead of an eye-glass, an object, or the image of an object, be looked at thro' a small hole in a thin plate or piece of paper, held close to the eye, it may be viewed very near to the eye, and, at the same distance, the apparent magnitude of the object will be the same in both cases. For if the hole be so small as to admit but a single ray from every distinct point of the object, these rays will fall upon the retina in as many other distinct points, and make a distinct image. They are only pencils or cones of rays, which have a sensible base, as the breadth of the pupil, that are capable, by their spreading on the retina, of producing an indistinct image. As very few rays, however, can be admitted through a small hole, there will seldom be light sufficient to view any object to advantage in this manner.

If no image be actually formed by the foci of the pencils without the eye, yet if, by the help of any eye-glass, the pencils of rays shall enter the pupil, just as they would have done from any place without the eye, the visual angle will be the same as if an image had actually been formed in that place. Objects will not appear inverted through this telescope, because the pencils which form the images of them, only cross one another once, *viz.* at the object-glass, as in natural vision they do in the pupil of the eye.

79 Galilean telescope more difficult of construction than others.

Such is the telescope that was first discovered and used by philosophers; and it is remarkable that it should be of a much more difficult construction than some other kinds that have been invented since. The great inconvenience attending it is, that the field of view is exceedingly small. For since the pencils of rays enter the eye very much diverging from one another, but few of them can be intercepted by the pupil; and this inconvenience increases with the magnifying power of the telescope; so that philosophers at this day cannot help wondering, that it was possible, with such an instrument, for Galileo and others to have made the discoveries they did. It must have required incredible patience and address. No other telescope, however, than this, was so much as thought of for many years after the discovery. Descartes, who wrote 30 years after, mentions no other as actually constructed, though Kepler had suggested some.

80 Telescopes improved by Kepler.

It is to this great man that we are indebted for the construction of what we now call the *astronomical telescope*, being the best adapted for the purpose of viewing the heavenly bodies. The *rationale* of this instrument is explained, and the advantages of it are clearly pointed out, by this philosopher, in his Catoptrics; but, what is very surprising, he never actually reduced his excellent theory into practice. Montucla conjectures, that the reason why he did not make trial of his new construction was, his not being aware of the great increase of the field of view; so that being engaged in other pursuits, he might not think it of much consequence to take any pains about the construction of an instrument, which could do little more than answer the same purpose with those of which he was already possessed. He must also have foreseen, that the length of this telescope must have been greater in proportion to its magnifying power; so that it might appear to him to be upon the whole not quite so good a construction as the former.

81 His method first put in practice by Scheiner.

It was not long, however, before Kepler's new scheme of a telescope was executed; and the first person who actually made an instrument of this construction, was Father Scheiner, who has given a description of it in his *Rosa Ursina*, published in 1630. If, says he, you insert two similar lenses (that is, both convex) in a tube, and place your eye at a convenient distance, you will see all terrestrial objects inverted, indeed, but magnified and very distinct, with a considerable extent of view. He afterwards subjoins an account of a telescope of a different construction, with two convex eye-glasses, which again reverses the images, and makes them appear in their natural position. This disposition of the lenses had also been pointed out by Kepler, but had not been reduced to practice by him, any more than the former. This construction, however, answered the end but very imperfectly; and Father Rheita presently after hit upon a better construction, using three eye-glasses instead of two. This got the name of the *terrestrial telescope*, being chiefly used for terrestrial objects.

The first and last of these constructions are those which are now in common use. The proportion in which the first telescope magnifies, is as the focal length of the object-glass to that of the eye-glass.— The only difference between the Galilean telescope and the other is, that the pencils by which the extremities of any object are seen in this case, enter the eye diverging; whereas, in the other, they enter it converging; but if the sphere of concavity in the eye-glass of the Galilean telescope be equal to the sphere of convexity in the eye-glass of another telescope, their magnifying power will be the same. The concave eye-glass, however, being placed between the object-glass and its focus, the Galilean telescope will be shorter than the other, by twice the focal length of the eye-glass. Consequently, if the length of the telescopes be the same, the Galilean will have the greater magnifying power.

82 Vision most distinct in the Galilean telescopes.

Vision is also more distinct in these telescopes; owing perhaps, in part, to there being no intermediate image between the eye and the object. Besides, the eye-glass being very thin in the centre, the rays will be less liable to be distorted by irregularities in the substance of the glass. Whatever be the cause, we can sometimes see Jupiter's satellites very clearly in a Galilean telescope not more than twenty inches or two feet long; when one of four or five feet, of the common sort, will hardly make them visible.

83 Binocular telescope.

The same Father Rheita, to whom we are indebted for the useful construction of a telescope for land-objects, invented a binocular telescope, which Father Cherubin, of Orleans, endeavoured to bring into use afterwards. It consists of two telescopes fastened together, and made to point to the same object. When this instrument is well fixed, the object appears larger, and nearer to the eye, when it is seen through both the

the telescopes, than through one of them only, tho' they have the very same magnifying power. But this is only an illusion, occasioned by the stronger impression that two equal images, equally illuminated, make upon the eye. This advantage, however, is counterbalanced by the inconvenience attending the use of it.

84 Telescopes of Campani and Divini.

The first who distinguished themselves in grinding telescopic glasses were two Italians, Eustachio Divini at Rome, and Campani at Bologna, whose fame was much supperior to that of Divini, or that of any other person of his time; though Divini himself pretended, that, in all the trials that were made with their glasses, his, of a great focal distance, performed better than those of Campani, and that his rival was not willing to try them fairly, viz. with equal eye-glasses. It is generally supposed, however, that Campani realy excelled Divini, both in the goodness and the focal length of his object-glasses. It was with telescopes made by Campani that Cassini discovered the nearest satellites of Saturn. They were made by the express order of Lewis XIV. and were of 86, 100, and 136 Parisian feet focal length.

Campani sold his lenses for a great price, and took every possible method to keep his art of making them a secret. His laboratory was inaccessible to all the world, till after his death; when it was purchased by Pope Benedict XIV. who made a present of it to the academy called the *Institute*, established in that city; and by the account which M. Fougeroux has given of what he could discover from it, we learn, that (except a machine, which M. Campani constructed, to work the basons on which he ground his glasses) the goodness of his lenses depended upon the clearness of his glass, his Venetian tripoli, the paper with which he polished his glasses, and his great skill and address as a workman. It was also the general opinion at Bologna, that he owed a great part of his reputation to the secrecy and air of mystery which he affected; and that he made a great number of object-glasses which he rejected, shewing only those that were very good. He made few lenses of a very great focal distance; and having the misfortune to break one of 141 feet in two pieces, he took incredible pains to join the two parts together, which he did at length effectually, so that it was used as if it had been entire; but it is not probable that he would have taken so much pains about it, if, as he pretended, he could very easily have made another as good.

Sir Paul Neille, Dr Hooke says, made telescopes of 36 feet, pretty good, and one of 50, but not of proportional goodness. Afterwards Mr Reive first, and then Mr Cox, who were the most celebrated in England as grinders of optic glasses, made some good ones of 50 and 60 feet focal distance, and Mr Cox made one of 100; but how good, Dr Hooke could not assert.

Borelli, also, in France made object-glasses of a great focal length, one of which he presented to the royal society; but we do not find any particular account of their goodness.

85 Extraordinary object-glass made by Mr Auzout.

With respect to the focal length of telescopes, these and all others were far exceeded by M. Auzout, who made one object-glass of 600 feet focus; but he was never able to manage it, so as to make any use of it. Hartsocker is even said to have made some of a still greater focal length; but this ingenious mechanic, finding it impossible to make use of object-glasses, the focal distance of which was much less than this, when they were inclosed in a tube, contrived a method of using them without a tube, by fixing them at the top of a tree, a high wall, or the roof of a house.

86 Telescopes used without tubes.

Mr Huygens, who was also an excellent mechanic, made considerable improvements in the method of using an object-glass without a tube. He placed it at the top of a very long pole, having previously inclosed it in a short tube, which was made to turn in all directions, by means of a ball and socket. The axis of this tube he could command with a fine silken string, so as to bring it into a line with the axis of another short tube, which he held in his hand, and which contained the eye-glass. In this method he could make use of object-glasses of the greatest magnifying power, at whatever altitude his object was, and even in the zenith, provided his pole was as long as his telescope; and, to adapt it to the view of objects of different altitudes, he had a contrivance, by which he could raise or depress a stage that supported his object-glass at pleasure.

M. De la Hire made some improvement in this method of managing the object-glass, fixing it in the centre of a board, and not in a tube; but as it is not probable that this method will ever be made use of, since the discovery of both reflecting and achromatic telescopes, which are now brought to great perfection, and have even micrometers adapted to them, we shall not describe this apparatus minutely; but shall only gave a drawing of M. Huygens's pole, which, with a very short explanation, will be sufficient for the purpose. In fig. 1. *a* represents a pulley, by the help of which a stage *c*, *d*, *e*, *f*, (that supports the object-glass, *k*, and the apparatus belonging to it) may be raised higher or lower at pleasure, the whole being counterpoised by the weight *h*, fastened to a string *g*. *n*, Is a weight, by means of which the centre of gravity of the apparatus belonging to the object-glass is kept in the ball and socket, so that it may be easily managed by the string *l*, *u*, and its axis brought into a line with the eye-glass at *a*. When it was very dark, M. Huygens was obliged to make his object-glass visible by a lantern, *y*, so constructed as to throw the rays of light in a parallel direction up to it. Plate CCVIII.

The recollection of the incredible pains which philosophers of the last age took in making observations, and the great expences they were obliged to be at for that purpose, should make us sensible of the obligations we are under to such men as Gregory, Newton, and Dollond, who have enabled us to get clearer and more satisfactory views of the remote parts of our system, with much less labour and expence; and should likewise make us more diligent and solicitous to derive all the advantages we possibly can from such capital improvements.

87 Why dioptric telescopes must be made so long.

The reason why it is necessary to make the common dioptric telescopes so very long, is, that the length of them must be increased in no less a proportion than the duplicate of the increase of their magnifying power; so that, in order to magnify twice as much as before, with the same light and distinctness, the telescope must be lengthened four times; and to

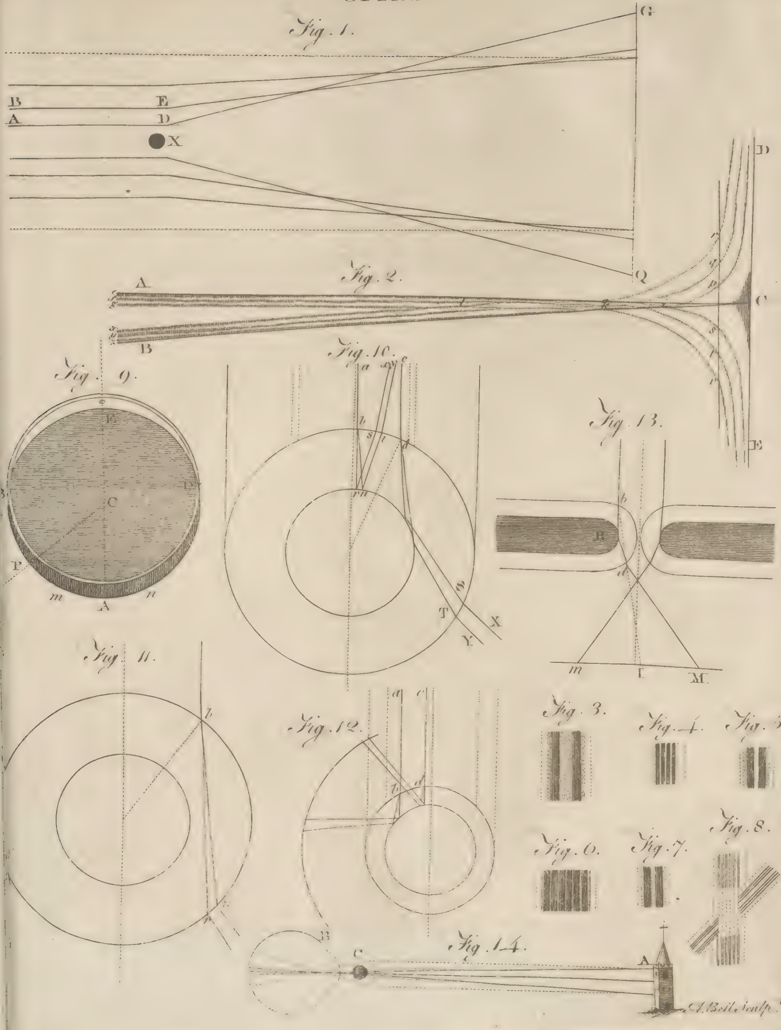


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.
A. Bell sculp.

to magnify thrice as much, nine times; and so on.

88 Of the apertures of refracting telescopes.

Before we mention the *reflecting telescope*, it must be observed, that M. Auzout, in a paper delivered to the Royal Society, observed, that the apertures which the object-glasses of refracting telescopes can bear with distinctness, are in about a sub-duplicate proportion to their lengths; and upon this supposition he drew up a table of the apertures proper for object-glasses of a great variety of focal lengths, from 4 inches to 400 feet. Upon this occasion, however, Dr Hooke observed, that the same glass will bear a greater or less aperture, according to the less or greater light of the object. If, for instance, he was viewing the sun, or Venus, or any of the fixed stars, he used smaller apertures: but if he wanted to view the moon by daylight; or Saturn, Jupiter, or Mars, by night; he used a larger aperture.

But the merit of all these improvements was in a manner cancelled by the discovery of the much more commodious *reflecting telescope*. For a refracting telescope, even of 1000 feet focus, supposing it possible to be made use of, could not be made to magnify with distinctness more than 1000 times; whereas a reflecting telescope, not exceeding 9 or 10 feet, will magnify 1200 times.

89 History of the reflecting telescope.

"It must be acknowledged, (says Dr Smith in his *Complete System of Optics*), that Mr James Gregory of Aberdeen was the first inventor of the reflecting telescope; but his construction is quite different from Sir Isaac Newton's, and not nearly so advantageous."

But, according to Dr Pringle, Mersennus was the man who entertained the first thought of a reflector. A telescope with specula he certainly proposed to the celebrated Descartes many years before Gregory's invention, though indeed in a manner so very unsatisfactory, that Descartes, who had given particular attention to the improvement of the telescope, was so far from approving the proposal, that he endeavoured to convince Mersennus of its fallacy (A). Dr Smith, it appears, had never perused the two letters of Descartes to Mersennus which briefly touch on that subject.

Again, as to his assertion, that Gregory's construction was not nearly so advantageous as Newton's, it may be accounted for from his having set it down early in the composition of his work, and forgetting to qualify it afterwards, when, before the publication, he had received pretty sure information to the contrary. Or perhaps he was influenced by the example of Dr Bradley, who had been a most successful observer, and yet had always preferred the Newtonian telescope to the other. But we must certainly adjudge the superiority to the latter, as that is now, and has been for several years past, the only instrument of the kind in request.

Gregory, a young man of an uncommon genius, was led to the invention, in seeking to correct two imperfections of the common telescope: the first was its too great length, which made it less manageable; the second, the incorrectness of the image. Mathematicians had demonstrated, that a pencil of rays could not be collected in a single point by a spherical lens; and also, that the image transmitted by such a lens would be in some degree incurvated. These inconveniences he believed would be obviated by substituting for the object-glass a metallic speculum, of a parabolic figure, to receive the image, and to reflect it towards a small speculum of the same metal: this again was to return the image to an eye-glass placed behind the great speculum, which for that purpose was to be perforated in its centre. This construction he published in 1663, in his *Optica Promota*. But as Gregory, as he himself declares, was endowed with no mechanical dexterity, nor could find any workman capable of realizing his invention, after some fruitless attempts in that way he was obliged to give up the pursuit: and probably, had not some new discoveries been made in light and colours, a reflecting telescope would never more have been thought of, considering the difficulty of the execution, and the small advantages that could accrue from it, deducible from the principles of optics that were then known.

But Newton, whose happy genius for experimental knowledge was equal to that for geometry, happily interposed, and saved this noble invention from well-nigh perishing in its infant-state. He likewise at an early period of life had applied himself to the improvement of the telescope; but imagining that Gregory's specula were neither very necessary, nor likely to be executed, he began with prosecuting the views of Descartes, who aimed at making a more perfect image of an object, by grinding lenses, not to the figure of a sphere, but to that of one of the conic sections. Now, whilst he was thus employed, three years after Gregory's publication, he happened to take to the examination of the colours formed by a prism, and having by the means of that simple instrument discovered the different refrangibility of the rays of light, he then perceived that the errors of telescopes, arising from that cause alone, were some hundred times greater than such as were occasioned by the spherical figure of lenses. This circumstance, forced, as it were, Newton to fall into Gregory's track, and to turn his thoughts to reflectors. "The different refrangibility of the rays of light (says he, in a letter to Mr Oldenburg, secretary to the Royal Society, dated in Feb. 1672), made me take reflections into consideration; and finding them regular, so that the angle of reflection of all sorts of rays was equal to the angle of incidence, I understood, that by their mediation optic instruments might be brought to any degree of perfection imaginable, providing a reflecting substance could be found which would polish as finely as glass, and reflect as much light as glass transmits, and the art of communicating to it a parabolic figure be also obtained. Amidst these thoughts I was forced from Cambribge by the intervening plague, and it was more than two years before I proceeded further."

It appears, then, that if Newton was not the first inventor of the reflecting telescope, he was the main and effectual inventor. By the force of his admirable genius, he fell upon this new property of light; and thereby found, that all lenses, of whatever figure, would be affected more or less with such prismatic aberrations of

(A) *Lettres de Descartes, tome* ii. printed at Paris in 1657, lett. 29. and 32. See this point discussed by two learned and candid authors, M. le Roi in the *Encyclopedie*, under the article *Telescope*, and M. Montecula in *Hist. des Mathem. tome* ii. p. 644.

of the rays as would be an insuperable obstacle to the perfection of a dioptric telescope.

It was towards the end of 1668, or in the beginning of the following year, when Newton, being thus obliged to have recourse to reflectors, and not relying on any artificer for making his specula, set about the work himself, and early in the year 1672 completed two small reflecting telescopes. In these he ground the great speculum into a spherical concave; not but that he approved of the parabolic form proposed by Gregory, though he found himself unable to accomplish it. In the letter that accompanied one of these instruments which he presented to the Society, he writes, "that though he then despaired of performing that work (to wit, the parabolic figure of the great speculum) by geometrical rules, yet he doubted not but that the thing might in some measure be accomplished by mechanical devices."

Not less did the difficulty appear to find a metallic substance that would be of a proper hardness, have the fewest pores, and receive the smoothest polish: a difficulty in truth which he deemed almost unsurmountable, when he considered, that every irregularity in a reflecting surface would make the rays of light stray five or six times more out of their due course, than the like irregularities in a refracting one. In another letter, written soon after, he tells the secretary, "that he was very sensible that metal reflects less light than glass transmits; but as he had found some metallic substances to be more strongly reflective than others, to polish better, and to be freer from tarnishing than others, so he hoped that there might in time be found out some substances much freer from these inconveniences than any yet known." Newton therefore laboured till he found a composition that answered in some degree, and left it to those who should come after him to find a better, and presented a reflecting telescope to the Royal Society; from whom he received such thanks as were due to so curious and valuable a present. And Huygens, one of the greatest geniuses of the age, and himself a distinguished improver of the refractor, no sooner was informed by Mr Oldenburg of the discovery, than he wrote in answer, "that it was an admirable telescope; and that Mr Newton had well considered the advantage which a concave speculum had above convex glasses in collecting the parallel rays, which according to his own calculation was very great: Hence that Mr Newton could give a far greater aperture to that speculum than to an object-glass of the same distance of focus, and consequently much more magnify in his way than by an ordinary telescope: Besides, that by the reflector he avoided an inconvenience inseparable from object-glasses, which was the obliquity of both their surfaces, which vitiated the refraction of the rays that pass towards the sides of the glass, and did more hurt than men were aware of: Again, that by the mere reflection of the metalline speculum there were not so many rays lost as in glasses, which reflected a considerable quantity by each of their surfaces, and besides intercepted many of them by the obscurity of their matter: That the main business would be, to find a matter for this speculum that would bear as good and even a polish as glass. Lastly, he believed that Mr Newton had not been without considering the advantage which a parabolic speculum would have over a spherical one in this construction; but had despaired, as he himself had done, of working other surfaces than spherical ones with due exactness." Huygens was not satisfied with thus expressing to the society his high approbation of the late invention; but drew up a favourable account of the new telescope, which he caused to be published in the *Journal des Scavans* for the year 1672, and by that channel it was soon known over Europe.

But how excellent soever the contrivance was; how well soever supported and announced to the public; yet whether it was that the artists were deterred by the difficulty and labour of the work, or that the discoveries even of a Newton were not to be exempted from the general fatality attending great and useful inventions, *the making a slow and vexatious progress to the authors*; the fact is, that, excepting an unsuccessful attempt which the society made, by employing an artificer to imitate the Newtonian construction, but upon a larger scale, and a disguised Gregorian telescope, set up by Cassegrain abroad as a rival to Newton's, and that in theory only (for it never was put in execution by the author), no reflector was heard of for nearly half a century after. But when that period was elapsed, a reflecting telescope was at last produced to the world of the Newtonian construction by Dr Hadley, which the author had the satisfaction to find executed in such a manner as left no room to fear that the invention would any longer continue in obscurity.

This memorable event was owing to the genius, dexterity, and application, of Mr Hadley the inventor of the reflecting quadrant, another most valuable instrument. The two telescopes which Newton had made were but six inches long, were held in the hand for viewing objects, and in power were compared to a six-feet refractor; whereas Hadley's was above five feet long, was provided with a well-contrived apparatus far managing it, and equalled in performance the famous aerial telescope of Huygens of 123 feet in length. Excepting as to the manner of making the specula, we have, in the transactions of 1723, a complete description, with a figure, of this telescope, together with that of the machine for moving it; but, by a strange omission, Newton's name is not once mentioned in that paper, so that any person not acquainted with the history of the invention, and reading that account only, might be apt to conclude that Hadley had been the sole contriver of it.

The same celebrated artist, after finishing two telescopes of the Newtonian construction, accomplished a third in the Gregorian way; but, it would seem, less successfully, by Dr Smith's declaring so strongly in favour of the other. Mr Hadley spared no pains to instruct Mr Molyneux and the reverend Dr Bradley; and when those gentlemen had made a sufficient proficiency in the art, being desirous that these telescopes should become more public, they liberally communicated to some of the principal instrument-makers of London the knowledge they had acquired from him. Now such scholars, as it is easy to imagine, soon advanced beyond their masters, and completed reflectors by other and better methods than what had been taught them.

Cer-

Certain it is, at leaft, that Mr James Short, as early as the year 1734, had fignalized himfelf at Edinburgh by his work of this kind. Mr Maclaurin wrote that year to Dr Jurin, " that Mr Short, who had begun with making glafs fpecula, was then applying himfelf to improve the metallic; and that, by taking care of the figure, he was enabled to give them larger apertures than others had done; and that upon the whole they furpaffed in perfection all that he had feen of other workmen." He added, " that Mr Short's telefcopes were all of the Gregorian conftruction; and that he had much improved that excellent invention." This character of excellence Mr Short maintained to the laft; and with the more facility, as he had been well grounded both in the geometrical and philofophical principles of optics, and upon the whole was a moft intelligent perfon in whatever related to his profeffion. It was fuppofed he had fallen upon a method of giving the parabolic figure to his great fpeculum; a point of perfection that Gregory and Newton had wifhed for, but defpaired of attaining; and that Hadley had never, as far as we know, attempted, either in his Newtonian or Gregorian telefcope. Mr Short indeed faid he had acquired that faculty, but never would tell by what peculiar means he effected it; fo that the fecret of working that configuration, whatever it was, as far as it then appeared, died with that ingenious artift. Mr Mudge, however, hath lately realized the expectation of Sir Ifaac Newton, who, above 100 years ago, prefaged that the public would one day poffefs a parabolic fpeculum, not accomplifhed by mathematical rules, but by mechanical devices.

This was a *defideratum*, but it was not the only want fupplied by this gentleman: he has taught us likewife a better compofition of metals for the fpecula, how to grind them better, and how to give them a finer polifh; and this laft part, (namely, the polifh), he remarks, was the moft difficult and effential of the whole operation. " In a word, (fays Sir John Pringle), I am of opinion, there is no optician in this great city (which hath been fo long and fo juftly renowned for ingenious and dextrous makers of every kind of mathematical inftruments) fo partial to his own abilities as not to acknowledge, that, however fome parts of the mechanical procefs now difclofed might have been known before by individuals of the profeffion, yet that Mr Mudge hath opened to them all fome new and important lights, and upon the whole hath greatly improved the art of making reflecting telefcopes."

90 Account of Mr Dollond's improvements

The greateft improvement in *refracting* telefcopes is that of Mr Dollond, of which an account has already been given in a preceding fection, wherein his difcoveries in the fcience of Optics were explained. But, befides the obligation we are under to him for correcting the abberration of the rays of light in the focus of object-glaffes, arifing from their different refrangibility, he made another confiderable improvement in telefcopes, viz. by correcting, in a great meafure, both this kind of aberration, and alfo that which arifes from the fpherical form of lenfes, by an expedient of a very different nature; viz. increafing the number of eye-glaffes.

If any perfon, fays he, would have the vifual angle of a telefcope to contain 20 degrees, the extreme pencils of the field muft be bent or refracted in an angle of 10 degrees; which, if it be performed by one eye-glafs, will caufe an aberration from the figure, in proportion to the cube of that angle; but if two glaffes are fo proportioned and fituated, as that the refraction may be equally divided between them, they will each of them produce a refraction equal to half the required angle; and therefore, the aberration being in proportion to the cube of half the angle taken twice over, will be but a fourth part of that which is in proportion to the cube of the whole angle; becaufe twice the cube of 1 is but $\frac{1}{4}$ of the cube of 2; fo the aberration from the figure, where two eye-glaffes are rightly proportioned, is but a fourth of what it muft unavoidably be where the whole is performed by a fingle eye-glafs. By the fame way of reafoning, when the refraction is divided between three glaffes, the aberration will be found to be but the ninth part of what would be produced from a fingle glafs; becaufe three times the cube of 1 is but one-ninth of the cube of 3. Whence it appears, that by increafing the number of eye-glaffes, the indiftinctnefs which is obferved near the borders of the field of a telefcope may be very much diminifhed, though not entirely taken away.

The method of correcting the errors arifing from the different refrangibility of light is of a different confideration from the former. For, whereas the errors from the figure can only be diminifhed in a certain proportion according to the number of glaffes, in this they may be entirely corrected by the addition of only one glafs; as we find in the aftronomical telefcope, that two eye-glaffes, rightly proportioned, will caufe the edges of objects to appear free from colours, quite to the borders of the field. Alfo in the day-telefcope, where no more than two eye-glaffes are abfolutely neceffary for erecting the object, we find, that by the addition of a third, rightly fituated, the colours, which would otherwife make the image confufed, are entirely removed. This, however, is to be underftood with fome limitation: for though the different colours into which the extreme pencils muft neceffarily be divided by the edges of the eye-glaffes, may in this manner be brought to the eye in a direction parallel to each other, fo as, by the humours of the eye, to be made to converge to a point on the retina; yet, if the glaffes exceed a certain length, the colours may be fpread too wide, to be capable of being admitted thro' the pupil or aperture of the eye; which is the reafon, that in long telefcopes, conftructed in the common manner, with three eye-glaffes, the field is always very much contracted.

Thefe confiderations firft fet Mr Dollond on contriving how to enlarge the field, by increafing the number of eye-glaffes without any hindrance to the diftinctnefs or brightnefs of the image; and though others had been about the fame work before, yet, obferving that fome five-glafs telefcopes which were then made would admit of farther improvement, he endeavoured to conftruct one with the fame number of glaffes in a better manner; which fo far anfwered his expectations, as to be allowed by the beft judges to be a confiderable improvement on the former.

Encouraged by this fuccefs, he refolved to try if he could

could not make some farther enlargement of the field, by the addition of another glass, and by placing and proportioning the glasses in such a manner as to correct the aberrations as much as possible, without any detriment to the distinctness; and at last he obtained as large a field as is convenient or necessary, and that even in the longest telescopes that can be made.

These telescopes with six glasses having been well received, and some of them being gone into foreign parts, it seemed a proper time to the author to settle the date of his invention; on which account he drew up a letter, which he addressed to Mr Short, and which was read at the Royal Society, March 1, 1753.

91 Mr Smith's proposal to shorten telescopes.

Various other attempts were made about this time to shorten and otherwise improve telescopes. Among these we must just mention that of Mr Caleb Smith, who, after giving much attention to the subject, thought that he had found it possible to rectify the errors which arise from the different degrees of refrangibility, on the principle that the sines of refraction, or rays differently refrangible, are to one another in a given proportion, when their sines of incidence are equal; and the method which he proposed for this purpose was to make the speculums of glass instead of metal, the two surfaces having different degrees of concavity. But we do not find that his scheme was ever executed; nor is it probable, for reasons which have been mentioned, that any advantage could be made of it.

92 Equatorial telescope, or portable observatory

To Mr Short we are indebted for the excellent contrivance of an equatorial telescope, or, as he likewise called it, a *portable observatory;* for with it pretty accurate observations may be made with very little trouble, by those who have no building adapted to the purpose. The instrument consists of an ingenious piece of machinery, by the help of which a telescope mounted upon it may be directed to any degree of right ascension or declination, so that the place of any of the heavenly bodies being known, they may be found without any trouble, even in the day-time. Also, being made to turn parallel to the equator, any object is easily kept in view, or recovered, without moving the eye from its situation. By this instrument, Mr Short informs us, that most of the stars of the first and second magnitude have been seen even at mid-day, and the sun shining bright; as also Mercury, Venus, and Jupiter. Saturn and Mars are not so easy to be seen, on account of the faintness of their light, except when the sun is but a few hours above the horizon. This particular effect depends upon the telescope excluding almost all the light, except what comes from the object itself, and which might otherwise efface the impression made by its weaker light upon the eye. Any telescope of the same magnifying power would have the same effect, could we be sure of pointing it right. For the same reason, also, it is that stars are visible in the day-time from the bottom of a deep pit.

93 How to observe the stars in the day-time.

In order to enable us to see the fixed stars in the day-time, it is necessary to exclude the extraneous light as much as possible. For this reason the greater magnifying power of any telescope is used, the more easily a fixed star will be distinguished in the day-time; the light of the star remaining the same in all magnifying powers of the same telescope, but the ground upon which it is seen becoming darker by increasing the magnifying power; and the visibility of a star depends very much upon the difference between its own light and that of the ground upon which it is seen. A fixed star will be very nearly equally visible with telescopes of very different apertures, provided the magnifying power remains the same.

If a comet, or any other heavenly body, be viewed through this equatorial telescope, properly rectified, it is seen immediately by the help of the same machinery what is its true place in the heavens. Other astronomical problems may also be solved by it, with great ease and certainty. But a particular description of its construction and uses, will be afterwards given.

94 Mr Epinus's proposal for bending the tubes of telescopes.

M. Æpinus proposes to bend the tubes of long telescopes at right angles, fixing a plane mirror in the angle, in order to make them more commodious for viewing objects near the zenith of the observer; and he gives particular instructions how to make them in this form, especially when they are furnished with micrometers. We are also informed that a little plane speculum is sometimes placed betwixt the last eye-glass and the eye in the reflecting telescopes, at an angle of 45°, for the same purpose.

95 History of microscopes

The invention of MICROSCOPES was not much later than that of telescopes; and, according to Borellus, whose account we do not find to have been called in question by any person, we are indebted for them to the same author, at least to Z. Jansen, in conjunction with his son; and for this latter favour we may, perhaps, be considered as under more obligation to them than for the former, the microscope having more various and extensive uses, with respect to philosophy, than the telescope. In our ideas, however, it appears something greater, and more extraordinary, to be able to see objects too distant to be perceived by the naked eye, than those that are too near to be seen by us; and therefore there is more of the sublime in the telescope than the microscope. These two instruments, though different in their application, are notwithstanding very similar; as both of them assist us in the discovery of objects that we must otherwise have remained unacquainted with, by enlarging the angle which they subtend at the eye.

The Jansens, however, have not always enjoyed, undisturbed, that share of reputation to which they seem to be intitled, with respect either to the telescope or the microscope. The discovery of the latter, in particular, has generally been considered as more uncertain than that of the former. All that many writers say we can depend upon is, that microscopes were first used in Germany about the year 1621. Others say positively, that this instrument was the contrivance of Cornelius Drebell, no philosopher, but a man of curiosity and ingenuity, who also invented the thermometer.

According to Borellus, Zacharias Jansen and his son presented the first microscopes they had constructed to prince Maurice, and Albert archduke of Austria. William Borell, who gives this account in a letter to his brother Peter, says, that when he was ambassador in England, in 1619, Cornelius Drebell, with whom he was intimately acquainted, shewed him a microscope, which he said was the same the archduke had given him, and had been made by Jansen himself.

This

This inftrument was not fo fhort as they are generally made at prefent, but was fix feet long, confifting of a tube of gilt copper, an inch in diameter, fupported by three brafs pillars in the fhape of dolphins, on a bafe of ebony, on which the fmall objects were placed.

96 Microfcope made by Janfen. This telefcope was evidently a compound one, or rather fomething betwixt a telefcope and a microfcope, what we fhould now, perhaps, choofe to call a *megalafcope;* fo that it is poffible that fingle microfcopes might have been known, and in ufe, fome time before: but perhaps nobody thought of giving that name to fingle lenfes; though, from the firft ufe of lenfes, they could not but have been ufed for the purpofe of magnifying fmall objects. In this fenfe we have feen, that even the ancients were in poffeffion of microfcopes; and it appears from Jamblicus and Plutarch, quoted by Dr Rogers, that they gave fuch inftruments as they ufed for this purpofe the name of *dioptra*. As fpectacles were certainly in ufe long before the invention of telefcopes, one can hardly help concluding, that lenfes muft have been made fmaller, and more convex, for the purpofe of magnifying of minute objects; efpecially as the application of this kind of microfcope was nearly the fame with that of a fpectacle glafs, both of them being held clofe to the eye. At what time lenfes were made fo fmall as we now generally ufe them for magnifying in fingle microfcopes, we have not found. But as this muft neceffarily have been done gradually, the only proper object of inquiry is the invention of the double, or compound microfcope; and this is clearly given, by the evidence of Borellus above-mentioned, to Zacharias Janfen, the inventor of the telefcope, or his fon.

The invention of compound microfcopes is claimed by the fame Fontana who claimed the difcovery of telefcopes; and though he did not publifh any account of this improvement till the year 1646 (nothwithftanding he pretended to have made the difcovery in 1618), Montucla, not having attended perhaps to the teftimony of Borellus, is willing to allow his claim, as he thought there was no other perfon who feemed to have any better right to it.

97 By Divini. Euftachio Divini made microfcopes with two common object-glaffes, and two plano-convex eye-glaffes joined together on their convex fides fo as to meet in a point. The tube in which they were inclofed was as big as a man's leg, and the eye-glaffes almoft as broad as the palm of a man's hand. Mr Oldenburg, fecretary to the royal fociety, received an account of this inftrument from Rome, and read it at one of their meetings, Auguft 6, 1668.

98 By Hartfocker. It was in this period that Hartfocker improved fingle microfcopes, by ufing fmall globules of glafs, made by melting them in the flame of a candle, inftead of the lenfes which had before been made ufe of for that purpofe. By this means he firft difcovered the *animalcula in femine mafculino*, which gave rife to a new fyftem of generation. A microfcope of this kind, confifting of a globule of $\frac{1}{10}$ of an inch in diameter, M. Huygens demonftrated to magnify 100 times; and fince it is eafy to make them of lefs than half a line in diameter, they may be made to magnify 300 times. Were it not for the difficulty of applying objects to thefe magnifiers, the want of light, and the fmall field of diftinct vifion, they would certainly have been the moft perfect of all microfcopes.

99 By Leeuwenhoek. But no man diftinguifhed himfelf fo much by microfcopical difcoveries as the famous M. Leeuenhoek, though he ufed only fingle lenfes with fhort foci, preferring diftinctnefs of vifion to a large magnifying power.

M. Leeuwenhoek's microfcopes were all fingle ones, each of them confifting of a fmall double convex-glafs, fet in a focket between two filver plates rivetted together, and pierced with a fmall hole; and the object was placed on the point of a needle, fo contrived, as to be placed at any diftance from the lens. If the objects were folid, he faftened them with glue; and if they were fluid, or on other accounts required to be fpread upon glafs, he placed them on a fmall piece of Mufcovy talc, or glafs blown very thin; which he afterwards glued to his needle. He had, however, a different apparatus for viewing the circulation of the blood, which he could fix to the fame microfcopes.

The greateft part of his mifcrofcopes M. Leeuwenhoek bequeathed to the royal fociety. They were contained in a fmall Indian cabinet, in the drawers of which were 13 little boxes, or cafes, in each of which were two microfcopes, neatly fitted up in filver; and both the glafs and the apparatus were made with his own hands.

The glafs of all thefe lenfes is exceedingly clear, but none of them magnifies fo much as thofe globules which are frequently ufed in other microfcopes; but Mr Folkes, who examined them, thought that they fhewed objects with much greater diftinctnefs, which M. Leeuwenhoek principally valued. His difcoveries, however, are to be afcribed not fo much to the goodnefs of his glaffes, as to his great judgment, acquired by long experience, in ufing them. He alfo particularly excelled in his manner of preparing objects for being viewed to the moft advantage.

Mr Baker, who alfo examined M. Leeuwenhoek's microfcopes, and made a report concerning them to the royal fociety, found that the greateft magnifier among them enlarged the diameter of an object about 160 times, but that all the reft fell much fhort of that power; fo he concluded that M. Leeuenhoek muft have had other microfcopes of a much greater magnifying power for many of his difcoveries. And it appears, he fays, by many circumftances, that he had fuch microfcopes.

It appears from M. Leeuwenhoek's writings, that he was not unacquainted with the method of viewing opaque objects by means of a fmall concave reflecting mirror, which was afterwards improved by M. Lieberkhun. For, after defcribing his apparatus for viewing eels in glafs tubes, he adds, that he had an inftrument to which he fcrewed a microfcope fet in brafs, upon which microfcope he faftened a little difh of brafs, probably that his eye might be thereby affifted to fee objects better; for he fays he had filed the brafs which was round his microfcope as bright as he could, that the light, while he was viewing objects, might be reflected from it as much as poffible. This microfcope, with its difh, (of which an exact copy, taken from the picture in his works, may be feen, Plate CCVIII. fig. 2.) feems fo like our opaque microfcope, with its filver fpeculum, that it may well be fuppofed to have given the hint to the ingenious inven-

ventor of it, provided he ever attended to it.

100 Wilſon's microſcope.

In 1702, Mr Wilſon made ſeveral ingenious improvements in the method of uſing ſingle magnifiers, for the purpoſe of viewing tranſparent objects; and they have been ſo generally approved, that hardly any other method is made uſe of at this day. The capital advantage attending this microſcope conſiſts in its being furniſhed with a pretty large lens, to throw light upon the objects, and alſo with a fine ſcrew and ſpring, to bring them nearer, or remove them farther from the magnifier at pleaſure. This microſcope is alſo a neceſſary part of the ſolar microſcope, invented afterwards.

101 Adams's method of making globules for large magnifiers.

In 1710, Mr Adams gave to the Royal Society the following account of his method of making ſmall globules for large magnifiers. He took a piece of fine window-glaſs, and cut it with a diamond into as many lengths as he thought proper, not exceeding $\frac{1}{8}$ of an inch in breadth; then, holding one of them between the fore-finger and thumb of each hand over a very fine flame, till the glaſs began to ſoften, he drew it out till it was as fine as a hair, and broke; then putting each of the ends into the pureſt part of the flame, he had two globules preſently, which he could make larger or leſs at pleaſure. If they were held a long time in the flame, they would have ſpots in them, ſo that he drew them out preſently after they became round. The ſtem he broke off as near to the globule as he could, and lodging the remainder between the plates, in which holes were drilled exactly round, the microſcope, he ſays, performed to admiration. Through theſe magnifiers, he ſays, that the ſame thread of very fine muſlin appeared three or four times bigger than it did in the largeſt of Mr Wilſon's magnifiers.

102 Temporary microſcopes by Mr Grey.

The ingenious Mr Grey hit upon a very eaſy expedient to make very good temporary microſcopes, at a very little expence. They conſiſt of nothing but very ſmall drops of water, taken up with a point of a pin, and put into a ſmall hole made in a piece of metal. Theſe globules of water do not, indeed, magnify ſo much as thoſe which are made of glaſs of the ſame ſize, becauſe the refractive power of water is not ſo great; but the ſame purpoſe will be anſwered nearly as well by making them ſomewhat ſmaller.

The ſame ingenious perſon, obſerving that ſmall heterogeneous particles incloſed in the glaſs of which microſcopes are made, were much magnified when thoſe glaſſes were looked through, thought of making his microſcopes of water that contained living animalcula, to ſee how they would look in this new ſituation; and he found his ſcheme to anſwer even beyond his utmoſt expectation, ſo that he could not even account for their being magnified ſo much as they were: for it was much more than they would have been magnified if they had been placed beyond the globule, in the proper place for viewing objects. But Montucla obſerves, that, when any object is incloſed within this ſmall tranſparent globule, the hinder-part of it acts like a concave mirror, provided they be ſituated between that ſurface and the focus; and that, by this means, they are magnified above $3\frac{1}{2}$ times more than they would have been in the uſual way.

After the happy execution of the reflecting teleſcope, it was natural to expect that attempts would alſo be made to render a ſimilar ſervice to microſcopes. Accordingly we find two plans of this kind. The firſt was that of Dr Robert Barker. His inſtrument differs in nothing from the reflecting teleſcope, excepting the diſtance of the two ſpeculums, in order to adapt it to thoſe pencils of rays which enter the teleſcope diverging; whereas they come from very diſtant objects nearly parallel to each other.

103 Dr Barker's reflecting microſcope.

This microſcope is not ſo eaſy to manage as the common ſort. For viſion by reflection, as it is much more perfect, ſo it is far more difficult than that by refraction. Nor is this microſcope ſo uſeful for any but very ſmall or tranſparent objects. For the object, being between the ſpeculum and image, would, if it were large and opaque, prevent a due reflection.

104 Dr Smith's reflecting microſcope.

In Dr Smith's reflecting microſcope there are two reflecting mirrors, one concave and the other convex, and the image is viewed by a lens.

This microſcope, though far from being executed in the beſt manner, performed, Dr Smith ſays, nearly as well as the very beſt refracting microſcopes; ſo that he did not doubt but that it would have excelled them, if it had been executed properly. Dr Smith's own account of this inſtrument may be ſeen in his Optics, Remarks, p. 94.

105 Solar microſcope, and that for opaque objects.

In 1738 or 1739, M. Lieberkuhn made two capital improvements in microſcopes, by the invention of the *ſolar microſcope*, and the *microſcope for opaque objects*. When he was in England in the winter of 1739, he ſhewed an apparatus of his own making, for each of theſe purpoſes, to ſeveral gentlemen of the Royal Society, as well as to ſome opticians, particularly Mr Cuff in Fleet-ſtreet, who took great pains to improve them.

The ſolar microſcope, as made by Mr Cuff, was compoſed of a tube, a looking-glaſs, a convex lens, and a Wilſon's microſcope. Of this, and of another conſtructed by Mr Martin, a particular deſcription will be afterwards given.

The microſcope for opaque objects remedies the inconvenience of having the dark ſide of an object next the eye. For by means of a concave ſpeculum of ſilver, highly poliſhed, in the centre of which a magnifying lens is placed, the object is ſo ſtrongly illuminated that it may be examined with all imaginable eaſe and pleaſure. A convenient apparatus of this kind, with four different ſpeculums and magnifiers of different powers, was brought to perfection by Mr Cuff.

M. Lieberkuhn made conſiderable improvements in his ſolar microſcope, particularly in adapting it to the view of opaque objects; but in what manner this end was effected, M. Æpinus, who was highly entertained with the performance, and who mentions the fact, was not able to recollect; and the death of the ingenious inventor prevented his publiſhing any account of it himſelf. M. Æpinus invites thoſe perſons who came into the poſſeſſion of M. Lieberkuhn's apparatus to publiſh an account of this inſtrument; but it doth not appear that his method was ever publiſhed.

This improvement of M. Lieberkuhn's induced M. Æpinus himſelf to attend to the ſubject; and by this means produced a very valuable improvement in this inſtrument. For by throwing the light upon the foreſide of any object by means of a mirror, before it is tranſmitted through the object-lens, all kinds of objects are equally well repreſented by it.

M.

106 Reflected light introduced into the microscope and magic lantern.

M. Euler proposed a scheme to introduce vision by reflected light into the magic lantern and solar microscope, by which many inconveniences to which those instruments are subject, might be avoided. For this purpose, he says, that nothing is necessary but a large concave mirror, perforated as for a telescope; and that the light be so situated, that none of it may pass directly through the perforation, so as to fall on the images of the objects upon the screen. He proposes to have four different machines, for objects of different sizes; the first for those of six feet long, the second for those of one foot, the third for those of two inches, and the fourth for those of two lines. An idea of this contrivance is given in Plate CCVIII. fig. 3. in which OD represents the concave mirror, E the object, *l*, *l* the lights, and A the lens, through which the rays are transmitted to the screen.

Several improvements were made in the apparatus to the solar microscope, as adapted to view opaque objects, by M. Zeiher, who made one construction for the larger kind of objects, and another for the small ones.

107 Mr Martin's improvement in the solar microscope.

Mr Martin having constructed a solar microscope of a larger size than common, for his own use, the illuminating lens being $4\frac{1}{2}$ inches in diameter, and all the other parts of the instrument in proportion, found, that by the help of an additional part, which he does not describe, he could see even opaque objects very well. If he had made the lens any larger, he was aware that the heat produced at the focus would be too great for the generality of objects to bear. The expence of this instrument, he says, does not much exceed the price of the common solar microscope.

108 Di Torres's extraordinary magnifying microscope.

The smallest globules, and consequently the greatest magnifiers, for microscopes, that have yet been executed, were made by T. Di Torre of Naples, who, in 1765, sent four of them to the Royal Society. The largest of them was only two Paris points in diameter, and it was said to magnify the diameter of an object 640 times. The second was the size of one Paris point, and the third was no more than half of a Paris point, or the 144th part of an inch in diameter, and was said to magnify the diameter of an object 2560 times. One of these globules was wanting when they came into the hands of Mr Baker, to whose examination they were referred by the Royal Society. This gentleman, so famous for his skill in microscopes, and his extraordinary expertness in managing them, was not able to make any use of these. With that which magnifies the least, he was not able to see any object with satisfaction; and he concludes his account with expressing his hopes only, that, as his eyes had been much used to microscopes, they were not injured by the attention he had given to them, though he believed there were few persons who would not have been blinded by it.

109 Could not be used by Mr Baker.

The construction of a telescope with six eye-glasses led M. Euler to a similar construction of microscopes, by introducing into them six lenses, one of which admits of so small an aperture, as to serve, instead of a diaphragm, to exclude all foreign light, though, as he says, it neither lessens the field of view, nor the brightness of objects.

110 Difficulties attending the construction of dioptric instruments.

The improvement of all dioptric instruments is greatly impeded by inequalities in the substance of the glass of which they are made; but though many attempts have been made to make glass without that imperfection, none of them have been hitherto quite effectual. M. A. D. Merklein, having found some glass which had been melted when a building was on fire, and which proved to make excellent object-glasses for telescopes, concluded that its peculiar goodness arose from its not having been disturbed when it was in a fluid state; and therefore he proposed to take the metal out of the furnace in iron vessels, of the same form that was wanted for the glass; and after it had been perfectly fluid in those vessels, to let it stand to cool, without any disturbance. But this is not always found to answer.

PART II. Theory of Optics.

This part of the science contains all that hath been discovered concerning the various motions of the rays of light either through different mediums, or when reflected from different substances in the same medium. It contains also the rationale of every thing which hath been discovered with regard to vision; the optical deceptions to which we are liable; and, in short, ought to give the reason of all the known optical phenomena.—The science is commonly divided into three parts, viz. dioptrics, which contains the laws of refraction, and the phenomena depending upon them; catoptrics, which contains the laws of reflection, and the phenomena which depend on them; and lastly chromatics, which treats of the phenomena of colour. But this definition is of no use in a treatise of Optics, as most of the phenomena depend both on refraction and reflection; colour itself not excepted. For this reason we have not followed that method of dividing our subject; but have explained the particular laws of refraction and reflection, afterwards showing how, by these, the most remarkable optical phenomena may be accounted for.

Sect. I. *Of the properties of Light in general.*

Without entering into any repetition of the controversies concerning the nature of Light, which are fully set forth under that article, we shall here give a brief description of its properties considered as the subject of the optical science, and which hold good in all cases without regard to other theories.

Every visible body emits or reflects inconceivably small particles of matter from each point of its surface, which issue from it continually (not unlike sparks from a coal) in straight lines and in all directions. These particles entering the eye, and striking upon the retina, (a nerve expanded on the back part of the eye to receive their impulses), excite in our minds the idea of light. And as they differ in substance, density, velocity, or magnitude, they produce in us the ideas of different colours; as will be explained in its proper place.

That the particles which constitute light are exceedingly small, appears from hence, *viz.* that if a hole be made through a piece of paper with a needle, rays of

Of Light.

of light from every object on the farther side of it are capable of passing through it at once without the least confusion; for any one of those objects may as clearly be seen through it, as if no rays passed through it from any of the rest. Further, if a candle is lighted, and there be no obstacle in the way to obstruct the progress of its rays, it will fill all the space within two miles of it every way with luminous particles, before it has lost the least sensible part of its substance thereby.

That these particles proceed from every point of the surface of a visible body, and in all directions, is clear from hence, *viz.* because wherever a spectator is placed with regard to the body, every point of that part of the surface which is turned towards him is visible to him. That they proceed from the body in right lines, we are assured, because just so many and no more will be intercepted in their passage to any place by an interposed object, as that object ought to intercept, supposing them to come in such lines.

The velocity with which they proceed from the surface of the visible body is no less surprising than their minuteness: the method whereby philosophers estimate their swiftness, is by observations made on the eclipses of Jupiter's satellites; which eclipses to us appear about seven minutes sooner than they ought to do by calculation, when the earth is placed between the sun and him, that is, when we are nearest to him; and as much later, when the sun is between him and us, at which time we are farthest from him; from whence it is concluded, that they require about seven minutes to pass over a space equal to the distance between the sun and us, which is about 95,000,000 of miles.

A stream of these particles issuing from the surface of a visible body in one and the same direction, is called a *ray of light*.

As rays proceed from a visible body in all directions, they necessarily become thinner and thinner, continually spreading themselves as they pass along into a larger space, and that in proportion to the squares of their distances from the body; that is, at the distance of two spaces, they are four times thinner than they are at one; at the distance of three spaces, nine times thinner, and so on: the reason of which is, because they spread themselves in a twofold manner, *viz.* upwards and downwards, as well as sidewise.

The particles of light are subject to the laws of attraction of cohesion, like other small bodies; for if a ray of light be made to pass by the edge of a knife, it will be diverted from its natural course, and be inflected towards the edge of the knife. The like inflection happens to a ray when it enters obliquely into a denser or rarer substance than that in which it was before, in which case it is said to be refracted; the laws of which refraction are the subject of the following section.

Sect. II. *Of Refraction.*

111 Refraction defined.

Light, when proceeding from a luminous body, without being reflected from any opaque substance, or inflected by passing very near one, is invariably found to proceed in straight lines, without the least deviation. But if it happens to pass from one medium to another, it always leaves the direction it had before, and assumes a new one; and this change of course is called its *refraction*. After having taken this new direction, it then proceeds invariably in a straight line till it meets with a different medium, when it is again turned out of its course. It must be observed, however, that tho' by this means we may cause the rays of light make any number of angles in their course, it is impossible for us to make them describe a curve, except in one single case, namely, where they pass through a medium, the density of which uniformly either increases or decreases. This is the case with the light of the celestial bodies, which passes downwards thro' our atmosphere, and likewise with that which is reflected upwards through it by terrestrial objects. In both these cases, it describes a curve of the hyperbolic kind; but at all other times it proceeds in straight lines, or in what may be taken for straight lines without any sensible error. 112

112 In what case the rays of light describe a curve.

Of Refraction.

§ 1. *The cause of Refraction, and the law by which it is performed.*

113 Phenomena of refraction solved by an attractive power in the medium.

The phenomena of refraction are explained by an attractive power in the medium through which light passes, in the following manner. All bodies being endowed with an attractive force, which is extended to some distance beyond their surfaces; when a ray of light passes out of a rarer into a denser medium (if this latter has a greater attractive force than the former, as is commonly the case) the ray, just before its entrance, will begin to be attracted towards the denser medium; and this attraction will continue to act upon it, till some time after it has entered the medium; and therefore, if a ray approaches a denser medium in a direction perpendicular to its surface, its velocity will be continually accelerated during its passage through the space in which that attraction exerts itself; and therefore, after it has passed that space, it will move on, till it arrives at the opposite side of the medium, with a greater degree of velocity than it had before it entered. So that in this case its velocity only will be altered. Whereas, if a ray enters a denser medium obliquely, it will not only have its velocity augmented thereby, but its direction will become less oblique to the surface. Just as when a stone is thrown downwards obliquely from a precipice, it falls to the surface of the ground in a direction nearer to a perpendicular one, than that with which it was thrown from the hand. From hence we see a ray of light, in passing out of a rarer into a denser medium, is refracted towards the perpendicular; that is, supposing a line drawn perpendicularly to the surface of the medium, through the point where the ray enters, and extended both ways, the ray in passing through the surface is refracted or bent towards the perpendicular line; or, which is the same thing, the line which it describes by its motion after it has passed through the surface, makes a less angle with the perpendicular, than the line it described before. All which may be illustrated in the following manner.

Let us suppose first, that the ray passes out of a vacuum into the denser medium ABCD, (fig. 4.) and that the attractive force of each particle in the medium is extended from its respective centre to a distance equal to that which is between the lines AB and EF, or AB and GH; and let KL be the path described by a ray of light in its progress towards the denser me-

Plate CCVIII.

medium. This ray, when it arrives at L, will enter the attractive forces of thofe particles which lie in AB the furface of the denfer medium, and will therefore ceafe to proceed any longer in the right line KLM, but will be diverted from its courfe by being attracted towards the line AB, and will begin to defcribe the curve LN, paffing thro' the furface AB in fome new direction, as OQ; thereby making a lefs angle with a line, as PR, drawn perpendicularly through the point N, than it would have done had it proceeded in its firft direction KLM.

Farther, whereas we have fuppofed the attractive force of each particle to be extended through a fpace equal to the diftance between AB and EF, it is evident, that the ray, after it has entered the furface, will ftill be attracted downwards, till it has arrived at the line EF; for, till that time, there will not be fo many particles above it which will attract it upwards, as below, that will attract it downwards. So that after it has entered the furface at N, in the direction OQ, it will not proceed in that direction, but will continue to defcribe a curve, as NS; after which it will proceed ftraight on towards the oppofite fide of the medium, being attracted equally every way; and therefore will at laft proceed in the direction XST, ftill nearer the perpendicular PR than before.

Now if we fuppofe ABYZ not to be a vacuum, but a rarer medium than the other, the cafe will ftill be the fame; but the ray will not be fo much refracted from its rectilineal courfe, becaufe the attraction of the particles of the upper medium being in a contrary direction to that of the attraction of thofe in the lower one, the attraction of the denfer medium will in fome meafure be deftroyed by that of the rarer.

On the contrary, when a ray paffes out of a denfer into a rarer medium, if its direction be perpendicular to the furface of the medium, it will only lofe fomewhat of its velocity, in paffing through the fpaces of attraction of that medium (that is, the fpace wherein it is attracted more one way than it is another.) If its direction be oblique, it will continually recede from the perpendicular during its paffage, and by that means have its obliquity increafed, juft as a ftone thrown up obliquely from the furface of the earth increafes its obliquity all the time it rifes. Thus, fuppofing the ray TS paffing out of the denfer medium ABCD into the rarer ABYZ, when it arrives at S it will begin to be attracted downwards, and fo will defcribe the curve SNL, and then proceed in the right line LK; making a larger angle with the perpendicular PR, than the line TSX in which it proceeded during its paffage through the other medium.

The fpace through which the attraction of cohefion of the particles of matter is extended is fo very fmall, that in confidering the progrefs of a ray of light out of one medium into another, the curvature it defcribes in paffing through the fpace of attraction is generally neglected; and its path is fuppofed to be bent, or, in the ufual terms, the ray is fuppofed to be refracted only in the point where it enters the denfer medium.

Now the line which a ray defcribes before it enters a denfer or a rarer medium, is called the *incident ray;* that which it defcribes after it has entered, is the *refracted ray.*

The angle comprehended between the incident ray and the perpendicular, is the *angle of incidence;* and that between the refracted ray and the perpendicular, is the *angle of refraction.*

There is a certain and immutable law or rule, by which refraction is always performed; and that is this: Whatever inclination a ray of light has to the furface of any medium before it enters it, the degree of refraction will always be fuch, that the proportion between the fine of the angle of its incidence, and that of the angle of its refraction, will always be the fame in that medium.

To illuftrate this: Let us fuppofe ABCD (fig. 5.) to reprefent a rarer, and ABEF a denfer medium: let GH be a ray of light paffing through the firft and entering the fecond at H, and let HI be the refracted ray: then fuppofing the perpendicular PR drawn thro' the point H, on the centre H, and with any radius, defcribe the circle APBR; and from G and I, where the incident and refracted rays cut the circle, let fall the lines GK and IL perpendicularly upon the line PR; the former of thefe will be the fine of the angle of incidence, the latter of refraction. Now if in this cafe the ray GH is fo refracted at H, that GK is double or triple, &c. of IL, then, whatever other inclination the ray GH might have had, the fine of its angle of incidence would have been double or triple, &c. to that of its angle of refraction. For inftance, had the ray paffed in the line MH before refraction, it would have paffed in fome line as HN afterwards, fo fituated that MO fhould have been double or triple &c. of NQ. Plate CCVIII.

When a ray paffes out of a vacuum into air, the fine of the angle of incidence is found to be to that of refraction, as 100036 to 100000.

When it paffes out of air into water, as about 4 to 3.

When out of air into glafs, as about 17 to 11.

When out of air into a diamond, as about 5 to 2.

This relation of the fine of the angle of incidence to that of refraction may be demonftrated mathematically in the following manner.

Lemma. If from a point at M (fig. 6.) taken any where without the circle PNQ, a line as MP be drawn paffing through L the centre of the circle, and terminated in the circumference at P, the product of MQ multiplied by MP is equal to the difference between the fquares of ML and PL.

Demonftration of the Lemma. Call MQ, a; and the radius of the circle LQ or LP, b; then will the diameter QP be expreffible by $2b$, and the whole line MP, by $a+2b$; then multiplying MQ by MP, that is, a by $a+2b$, we have for the product of this, $aa+2ab$. Now the fquare of the line ML, which is expreffible by $a+b$, is $aa+2ab+bb$; and the fquare of PL is bb; but the difference between thefe fquares, *viz.* $aa+2ab+bb$ and bb, is evidently $aa+2ab$; and therefore the product of MQ multiplied by MP is equal to the difference between the fquares of ML and PL. *Q. E. D.*

Demonftration of the Propofition. When a ray of light paffes through the fpace of attraction of any medium, it is evident that its motion will be fubject to the like laws with that of projectiles, provided we fuppofe it to be acted upon with an equal degree of force during its whole paffage through that fpace, as is commonly fuppofed to be the cafe in projectiles to whatever

Of Refraction.

ever height they are thrown from the earth. We will therefore suppose first, that the force of attraction of the denser medium is at all distances the same as far as it reaches, and that the ray proceeds out of a denser into a rarer medium; in which case it will be attracted back towards the denser medium, during its passage thro' the space of attraction, in like manner as a projectile thrown upwards is while it rises from the earth. Let then ABCD (fig. 6.) represent the denser medium, and ABEF the space of attraction; and let GH be a ray about to enter the force of attraction at H, and let GH be produced to M. Now it is evident, that, in this supposition, the ray, when at H, is in the same circumstances with a projectile about to be thrown upwards from H towards M: it will therefore describe a portion of a parabola as HI; to which the line HM will be a tangent at H; and the line IK, in which it would proceed after it had passed the space of attraction, a tangent to it at I; for after having left the attractive force at I, it goes straight on in its last direction. Let the perpendicular IR be drawn meeting GH produced in M, and let KI be produced to L. On the centre L, with the radius LI, describe the circle PNQ, let fall the perpendicular LO upon MR, and join the points L and N. Now it is demonstrated in the case of projectiles†, that the parameter of the point H is equal to $\frac{HMq}{MI}$, and therefore the parameter multiplied by MI is equal to HM*q*. And it is there farther demonstrated, that the said parameter is equal to four times the height which a body must fall from, to acquire the velocity the projectile has at H. This parameter therefore is a quantity not at all depending on the direction of the projectile, but on its velocity only; and consequently, in the present supposition, it is a given quantity, the ray GH being sudposed to have the same velocity, whatever is its inclination to the surface HB. Now the tangent KI being produced to L, will, by the property of the parabola, bisect the other tangent HM: wherefore the line LO being parallel to HR, MR will also be bisected in O; and adding the equal lines OI and ON to each part, MN will be equal to IR; but the line IR is also a line independent of the inclination of the ray GH, its length being determined by the breadth of the space of attraction ABEF only, and therefore MN is a given quantity. Now, whereas MI, when multiplied by the parameter of the point H, which before was shewn to be a given line, is equal to the square of HM, therefore the same line MI, when multiplied by any other given line (*viz.* MN) if it is not equal to, will nevertheless bear a given proportion to, the square of HM: but since MI multiplied by MN bears a given proportion (*viz.* a proportion that does not depend on the inclination of the ray GH) to the square of MH, its equal, *viz.* the product of MQ multiplied by MP, or what is equal to this, the difference between the squares of ML and PL (by the foregoing *lemma*), or, which is the same thing, of ML and LI, (because PL and LI are radii of the same circle), does so too. Now the square of ML bears also a given proportion to the square of MH (ML being equal to half MH); consequently there is a given proportion between the square of ML and the difference of the squares of ML and LI; and therefore there is a certain proportion between the lines themselves, *viz.* between ML and LI. But in every triangle the sides are proportionable to the sines of their opposite angles; therefore in the triangle MLI, the sine of the angle LMI has a given proportion to the sine of the angle LIM, or of its complement to two right ones MIK (for they have the same sine): But LMI, being an angle made by the incident ray GH produced, with the perpendicular RM, is the angle of incidence; and MIK, being made by the refracted ray IK, and the same perpendicular, is the angle of refraction; therefore in this case there is a constant ratio between the sine of the angle of incidence, and that of the angle of refraction.

Plate CCVIII.

† See the article *Projectiles*.

We have here supposed that the force of attraction is every where uniform; but if it be otherwise, provided it be the same every where at the same distances from the surface AB, the proportion between the forementioned sines will still be a given one. For, let us imagine the space of attraction divided into parallel planes, and the attraction to be the same through the whole breadth of each plane though different in different planes, the sine of the angle of incidence out of each will, by what has been demonstrated above, be to the sine of the angle of refraction into the next in a given ratio; and therefore, since the sine of the angle of refraction out of one will be the sine of the angle of incidence into the next, it is evident that the sine of the angle of incidence into the first will be in a given ratio to the sine of the angle of refraction out of the last. Now let us suppose the thickness of these planes diminished *in infinitum*, and their number proportionably increased, the law of refraction will still continue the same; and therefore, whether the attraction be uniform or not, there will be a constant ratio between the sine of the angle of incidence and of refraction. *Q. E. D.*

For the same reason that a ray is bent towards the perpendicular when passing from a rare medium into one that is denser, it is refracted from the perpendicular when it passes from a dense medium into one that is rarer—From this and the foregoing proposition may be deduced the following corollaries.

I. When parallel rays fall obliquely on a plane surface of a medium of different density, they are parallel also after refraction; for, having all the same inclination to the surface, they suffer an equal degree of refraction.

II. When diverging rays pass out of a rarer into a denser medium through a plain surface, they are made thereby to diverge less.

III. When they proceed out of a denser into a rarer medium, the contrary happens, and they diverge more.

IV. When converging rays pass out of a rarer into a denser medium through a plain surface, they are made thereby to converge less.

V. When converging rays proceed out of a denser into a rarer medium, they are refracted the contrary way, and so made to converge more.

All these may be illustrated in the following manner. 1. Let AB, CD (fig. 7.) be two parallel rays falling on the plain surface EF of a medium of different density: now because they both make equal angles of incidence with their respective perpendicular GH, IK, before refraction, they will make equal angles of refrac-

refraction with them afterwards, and so proceed on in the parallel lines BL, DM. 2. Let the diverging rays AB, AE, AF, (fig. 8.) pass out of a rarer into a denser medium through the plain surface GH, and let the ray AB be perpendicular to that surface; the rest being refracted towards their respective perpendiculars EK, FM, and those the most that fall the farthest from B, they will proceed in the directions EN and FO, diverging in a less degree from the ray AP than they did before refraction. 3. Had they proceeded out of a denser into a rarer medium, they would have been refracted from their perpendicular EK, FM; and those the most which were the most oblique, and therefore would have diverged more than before. 4. Let the converging rays AB, CD, EF (fig. 9.) pass out of a rarer into a denser medium through the plain surface GH, and let the ray AB be perpendicular to that surface; then the other rays being refracted towards their respective perpendiculars DK, FM; and EF, for instance, more than CD; they will proceed in the directions DN, FN, converging in a less degree towards the ray AN, than they did before. 5. Lastly, had the first medium been the denser, they would have refracted the other way, and therefore converged more.

VI. When rays proceed out of a rarer into a denser medium through a convex surface of the denser, if they are parallel before refraction, they become converging afterwards.—For in this case the perpendiculars at the points where the rays enter the surface are all drawn from the centre of the convexity on the other side; and therefore, as the rays are refracted towards these perpendiculars, they are necessarily refracted towards each other, and thereby made to converge.

VII. If they enter diverging, then for the same reason they are made to diverge less, to be parallel, or to converge, according to the degree of divergency they have before they enter.

For, if they diverge very much, their being bent towards their respective perpendiculars in passing thro' the surface, may only diminish the divergency; whereas, if they diverge in a small degree, it may make them parallel, or even to converge.

VIII. If they converge in such a manner as to tend directly towards the centre of convexity before they enter the surface, they fall in with their respective perpendiculars, and so pass on to the centre without suffering any refraction.

IX. If they converge less than their perpendiculars, that is, if they tend to a point beyond the centre of convexity, they are made by refraction to converge more; and if they converge more than their perpendiculars, that is, if they tend towards a point between the centre and the surface, then, by being refracted towards them, they are made to converge less.

This and the three foregoing corollaries may be illustrated in the following manner. 1. Let AB, CD (fig. 10.) be two parallel rays entering a denser medium through the convex surface DB, whose centre of convexity is E; and let one of these, viz. AB, be perpendicular to the surface. This will pass on through the centre, without suffering any refraction; but the other being oblique to the surface, will be refracted towards the perpendicular ED, and will therefore be made to proceed in some line, as DG, converging towards the other ray, and meeting it in G, which point for that reason is called the *focus*. 2. Had the ray CD diverged from the other, suppose in the line AD, it would, by being refracted towards its perpendicular ED, have been made either to diverge less, be parallel, or made to converge. 3. Let the line ED be produced to F, and if the ray had converged, so as to have described the line FD, it would have been coincident with its perpendicular, and have suffered no refraction at all. 4. If it had proceeded from any point between C and F, as from H, or, which is the same thing, towards any point beyond E in the line BE produced, it would have been made to converge more by being refracted towards the perpendicular DE, which converges more than it; and, had it proceeded from the same point, as I, on the other side of F, that is towards any point between B and E, it would then have converged more than its perpendicular, and so, being refracted towards it, would have been made to have converged less.

X. When rays proceed out of a denser into a rarer medium through a concave surface of the denser, the contrary happens in each case.

For, being now refracted from their respective perpendiculars, as they were before towards them, if they are parallel before refraction, they diverge afterwards; if they diverge, their divergency is increased; if they converge in the direction of their perpendiculars, they suffer no refraction; if they converge less than their respective perpendiculars, they are made to converge still less, to be parallel, or to diverge; if they converge more, their convergency is increased. All which may be clearly seen by the figure, without any further illustration; imagining the rays AD, CD, &c. bent the contrary way in their refractions to what they were in the former cases.

XI. When rays proceed out of a rarer into a denser medium through a concave surface of the denser, if they are parallel before refraction, they are made to diverge.—For in this case the perpendiculars at the points where the rays enter the surface, being drawn from a point on that side of the surface from which the rays tend; if we conceive them to pass through the surface, they will be so many diverging lines on the other side; and therefore the rays, after they have passed through the same points, must necessarily be rendered diverging in being refracted towards them.

XII. If they diverge before refraction, then, for the same reason, they are made to diverge more.

XIII. Unless they proceed directly from the centre; in which case they fall in with their perpendiculars, and suffer no refraction: Or from some point between the centre of convexity and the surface; for then they diverge more than their respective perpendiculars, and therefore being by refraction brought towards them they become less diverging.

XIV. If they converge, then, being refracted towards their perpendiculars, they are either made less converging, parallel, or diverging, according to the degree they converged in before refraction.

To illustrate this, and the three foregoing cases, 1. Let AB, CD (fig. 11.), be two parallel rays entering the concave and denser medium X, the centre of whose convexity is E, and the perpendicular to the refracting

refracting surface at the point D is EF: the ray AB, if we suppose it perpendicular to the surface at B, will proceed on directly to G; but the oblique one CD being refracted towards the perpendicular DF, will recede from the other ray AG in some line as DH. 2. If the ray CD had proceeded from A, diverging in the direction AD, it would have been bent nearer the perpendicular, and therefore have diverged more. 3. But if it had diverged from the centre E, it would have fallen in with the perpendicular EF, and not have been refracted at all: and had it proceeded from S, a point on the other side of the centre E, it would, by being refracted towards the perpendicular DF, have proceeded in some line nearer it than it would otherwise have done, and so would diverge less than before refraction. 4. If it had converged in the line LD, it would have been rendered less converging, parallel, or diverging, according to the degree of convergency which it had before it entered into the refracting surface.

XV. If the same rays proceed out of a denser into a rarer medium, through a convex surface of the denser, the contrary happens in each supposition. The parallels are made to converge; those which diverge less than their respective perpendiculars, that is, those which proceed from a point beyond the centre, are made less diverging, parallel, or converging, according to the degree in which they diverge before refraction; those which diverge more than their respective perpendiculars, that is, those which proceed from a point between the centre and the refracting surface, are made to diverge still more; and those which converge are made to converge more. All which may easily be seen by considering the situation of the rays AB, CD, &c. with respect to the perpendicular EF; and therefore requires no further illustration.

XVI. When diverging rays are by refraction made to converge, the nearer the radiant point (or point whence the rays proceed) is to the refracting surface, the farther is their focus from it on the other side, and *vice versa*. For the nearer the radiant point is to the refracting surface, the more the rays which fall upon the same points of it diverge before refraction, upon which account they converge the less afterwards.

XVII. When the radiant point is at that distance from the surface at which parallel rays coming through it from the other side would be collected by refraction, then rays flowing from that point become parallel on the other side, and are said to have their focus at an infinite distance. For the power of refraction in the medium is the same, whether the ray passes one way or other. For instance, if the parallel rays AB, CD, (fig. 10.) in passing through the refracting surface BD, are brought to a focus in G, then rays flowing from G as a radiant point, will afterwards proceed in the parallel lines BA and DC. And the point G, where the parallel rays AB and CD meet after refraction, is called the *focus of parallel rays*.

XVIII. When rays proceed from a point nearer the refracting surface than the focus of parallel rays, they continue to diverge after refraction, and their focus is then an imaginary one, and situated on the same side of the surface with the radiant. For, in this case, the divergency being greater than that which they would have if they had proceeded from the focus of parallel rays, they cannot be brought to a parallelism with one another, much less to converge; and therefore they continue to diverge, though in a less degree than before they passed through the refracting surface: upon which account they proceed after refraction as if they came from some point farther distant from the refracting surface than their radiant.

All these corollaries may be expressed more determinately, and demonstrated, in the following manner:

I. When rays pass out of one medium into another of different density through a plain surface; if they diverge, the focal distance will be to that of the radiant point; if they converge, it will be to that of the imaginary focus of the incident rays, as the sine of the angle of incidence is to that of the angle of refraction.

This proposition admits of four cases.

Case 1. Of diverging rays passing out of a rarer into a denser medium.

Dem. Let X (fig. 12.) represent a rarer, and Z a denser medium, separated from each other by the plane surface AB; suppose CE and CD to be two diverging rays proceeding from the point C, the one perpendicular to the surface, the other oblique; through E draw the perpendicular PK. The ray CD being perpendicular to the surface, will proceed on in the right line CQ; but the other falling on it obliquely at E, and there entering a denser medium, will suffer a refraction towards the perpendicular EK. Let then EG be the refracted ray, and produce it back till it intersects DC produced also in F; this will be the focal point. On the centre E, and with the radius EF, describe the circle AFBQ, and produce EC to H; draw HI the sine of the angle of incidence, and GK that of refraction; equal to this is FP or CM, which let be drawn. Now if we suppose the points D and E contiguous, or nearly so, then will the line HE be almost coincident with FD, and therefore FD will be to CD as HE to CE; but HE is to CE as HI to CM, because the triangles HIE and CME are similar; that is, the focal distance of the ray CE is to the distance of the radiant point, as the sine of the angle of incidence is to that of the angle of refraction. *Q. E. D.*

Obs. 1. Whereas the ratio of FE to ME, or, which is the same thing, that of nD to CD, bears the exact proportion of HI to CM, and because this (being the ratio of the sine of the angle of incidence to that of the angle of refraction) is always the same, the line In is in all inclinations of the ray CE, at the same distance from CM; consequently, had CE been coincident with CD, the point H had fallen upon n; and because the circle passes through both H and F, F would also have fallen upon n; upon which account the focus of the ray CE would have been there. But the ray CE being oblique to the surface DB, the point H is at some distance from n; and therefore the point F is necessarily so too, and the more so by how much the greater that distance is: from whence it is clear, that no two rays flowing from the radiant point C, and falling with different obliquities on the surface BD, will, after refraction there, proceed as from the same point; therefore, strictly speaking, there is no one

Of Refraction.

one point in the line D produced, that can more properly be called the *focus of rays flowing from* C, than another: for thofe which enter the refracting furface near D, will after refraction proceed, as has been obferved, from the parts abont *n;* thofe which enter near E, will flow as from the parts about F; thofe which enter about T, as from fome points in the line DF produced, &c. And it is farther to be obferved, that, when the angle DCE becomes large, the line *n*F increafes apace; wherefore thofe rays which fall near T, proceed, after refraction, as from a more diffufed fpace than thofe which fall at the fame diftance from each other near the point D. Upon which account it is ufual with optical writers to fuppofe the diftance between the points where the rays enter the plain furface of a refracting medium, to be inconfiderable with regard to the diftance of the radiant point, if they diverge; or to that of their imaginary focus, if they converge: and unlefs there be fome particular reafon to the contrary, they confider them as entering the refracting medium in a direction as nearly perpendicular to its furfaces as may be.

Case 2. Of diverging rays proceeding out of a denfer into a rarer medium.

Dem. Let X be the denfer, Z the rarer medium, FD and FE two diverging rays proceeding from the point F; and fuppofing the perpendicular PK drawn as before, FP will be the fine of the angle of incidence of the oblique ray FE; which in this cafe being refracted from the perpendicular, will pafs on in fome line as ER, which being produced back to the circumference of the circle, will cut the ray FD fomewhere, fuppofe in C; this therefore will be the imaginary focus of the refracted ray ER: draw RS the fine of the angle of refraction, to which HI will be equal: but here alfo FP, or its equal CM, is to HI as EC to EH, or (if the point D and E be confidered as contiguous) as DC to DF; that is, the fine of the angle of incidence is to the fine of the angle of refraction, as the focal diftance to that of the radiant point. *Q. E. D.*

Case 3. Of converging rays paffing out of a denfer medium into a rarer.

Dem. Let Z be the denfer, X the rarer medium, and GE the incident ray; this will be refracted from the perpendicular into a line, as EH; then all things remaining as before, GK, or its equal FP, or CM, will be the fine of the angle of incidence, and HI that of refraction: but thefe lines, as before, are to each other as DC to DF; that is, the focal diftance is to the diftance of the imaginary focus, as the fine of the angle of incidence to that of the angle of refraction. *Q. E. D.*

Case 4. Of converging rays paffing out of a rarer into a denfer medium.

Dem. Let Z be the rarer, X the denfer medium, and RE the incident ray; this will be refracted towards the perpendicular into a line, as EF; C will be the imaginary focus, and F the real one; HI, which is equal to RS, the fine of the angle of incidence, and FP that of the angle of refraction: but thefe are to each other, as DF to DC; and therefore the focal diftance is to that of the imaginary focus, as the fine of the angle of incidence is to that of the angle of refraction. *Q. E. D.*

II. When parallel rays fall upon a fpherical furface of different denfity, the focal diftance will be to the diftance of the centre of convexity, as the fine of the angle of incidence is to the difference between that fine and the fine of the angle of refraction.

This propofition admits of four cafes.

Case 1. Of parallel rays paffing out of a rarer into a denfer medium, through a convex furface of the denfer.

Plate CCVII.

Dem. Let AB (fig. 13.) reprefent a convex furface; C its centre of convexity; HA and DB two parallel rays, paffing out of the rarer medium X into the denfer Z, the one perpendicular to the refracting furface, the other oblique: draw CB; this being a radius, will be perpendicular to the furface at the point B; and the oblique ray DB, being in this cafe refracted towards the perpendicular, will proceed in fome line, as BF, meeting the other ray in F, which will therefore be the focal point: produce CB to N; then will DBN, or its equal BCA, be the angle of incidence, and FBC that of refraction. Now, whereas any angle has the fame fine with its complement to two right ones, the angle FCB being the complement of ACB, which is equal to the angle of incidence, may here be taken for that angle; and therefore, as the fides of a triangle have the fame relation to each other that the fines of their oppofite angles have, FB being oppofite to this angle, and FC being oppofite to the angle of refraction, they may here be confidered as the fines of the angles of incidence and of refraction. And for the fame reafon CB may be confidered as the fine of the angle CFB; which angle being, together with the angle FBC, equal to the external one ACB, (32. El. 1.) is itfelf equal to the difference between thofe two laft angles; and therefore the line FB is to CB as the fine of the angle of incidence is to the fine of an angle which is equal to the difference between the angle of incidence and of refraction. Now, becaufe in very fmall angles as thefe are, (for we fuppofe in this cafe alfo the diftance AB to vanifh, the reafon of which will be fhewn by-and-by,) their fines bear nearly the fame proportion to each other that they themfelves do, the diftance FB will be to CB as the fine of the angle of incidence is to the difference between that fine and the fine of the angle of refraction; but becaufe BA vanifhes, FB and FA are equal, and therefore FA is to CA in that proportion. *Q. E. D.*

Obs. 2. It appears from the foregoing demonftration, that the focal diftance of the oblique ray DB is fuch, that the line BF fhall be to the line CB or CA as the fine of the angle of incidence to the fine of an angle, which angle is equal to the difference between the angle of incidence and refraction; therefore, fo long as the angles BCA, &c. are fmall, fo long the line BF is pretty much of the fame length, becaufe fmall angles have nearly the fame relation to each other that their fines have. But when the point B is removed far from A, fo that the ray DB enters the furface, fuppofe about O, the angles BCA, &c. becoming large, the fine of the angle of incidence begins to bear a confiderably lefs proportion to the fine of an angle which is equal to the difference between the angle of incidence and refraction than before, and therefore the line BF begins to bear a much lefs proportion to BC; wherefore its length decreafes apace: upon which account thofe rays which enter the furface about

Of Refraction.

about O, not only meet nearer the centre of convexity than thofe which enter at A, but are collected into a more diffufed fpace. From hence it is, that the point where thofe only which enter near A are collected, is reckoned the true focus; and the diftance AB in all demonftrations relating to the foci of parallel rays entering a fpherical furface whether convex or concave, is fuppofed to vanifh.

Case 2. Of parallel rays paffing out of a denfer into a rarer medium through a concave furface of the denfer.

Dem. Let X be the denfer, Z the rarer medium. AB the furface by which they are feparated, C the centre of convexity, and HA and DB two parallel rays, as before. Through B, the point where the oblique ray DB enters the rarer medium, draw the perpendicular CN; and let the ray DB, being in this cafe refracted from the perpendicular, proceed in the direction BM; produce BM back to H; this will be the imaginary focus; and DBN, or its equal ACB, will be the angle of incidence, and CBM, or its equal HBN (for they are vertical) that of refraction: produce DB to L, and draw BF fuch, that the angle LBF may be equal to DBH: then becaufe NBD and DBH together are equal to NBH the angle of refraction, therefore BCA which is equal to the firft, and LBF which is equal to the fecond, are together equal to the angle of refraction; but LBF is equal to BFA (as being alternate to it); confequently BFA and BCA together are equal to the angle of refraction; and therefore fince one of them, *viz.* BCA, is equal to the angle of incidence, the other is the difference between that angle and the angle of refraction. Now FB, the fine of the angle FCB, or, which is the fame thing, of its complement to two right ones, BCA, the angle of incidence, is to CB the fine of the angle BFC, as FB to CB, that is, as HB to CB; for the angles DBH and LBF being equal, the lines BF and BH are fo too; but the diftance BA vanifhing, HB is to CB, as HA to CA: that is, the fine of the angle of incidence is to the fine of an angle which is the difference between the angle of incidence and refraction, or, becaufe the angles are fmall, to the difference between the fine of the angle of incidence and that of refraction, as the diftance of the focus from the furface is to that of the centre from the fame. *Q. E. D.*

Case 3. Of parallel rays paffing out of a rarer into a denfer medium through a concave furface.

Dem. Let X be the denfer medium having the concave furface AB, and let LB and FA be the incident rays. Now, whereas, when DB was the incident ray, and paffed out of a rarer into a denfer medium, as in Cafe 1. it was refracted into the line BF, this ray LB, having the fame inclination to the perpendicular, will alfo fuffer the fame degree of refraction, and will therefore pafs on afterwards in the line FB produced, *v. g.* towards P. So that, whereas in that cafe the point F was the real focus of the incident ray DB, the fame point will in this be the imaginary focus of the incident ray LB: but it was there demonftrated, that the diftance FA is to CA, as the fine of the angle of incidence is to the difference between that and the fine of the angle of refraction; therefore the focal diftance of the refracted ray BP is to the diftance of the centre of convexity in that proportion. *Q. E. D.*

Case 4. Of parallel rays paffing out of a denfer into a rarer medium through a convex furface of the denfer.

Dem. Let Z be the denfer medium, having the convex furface AB, and let LB and FA be the incident rays, as before. Now, whereas, when DB was the incident ray paffing out of a denfer into a rarer medium, it was refracted into BM, as in Cafe 2. having a point as H in the line MB produced for its imaginary focus; therefore LB, for the like reafon as was given in the laft cafe, will in this be refracted into BH, having the fame point H for its real focus. So that here alfo the focal diftance will be to that of the centre of convexity, as the fine of the angle of incidence is to the difference between that and the fine of the angle of refraction. *Q. E. D.*

III. When diverging or converging rays enter into a medium of different denfity through a fpherical furface, the ratio compounded of that which the focal diftance bears to the diftance of the radiant point (or of the imaginary focus of the incident rays, if they converge), and of that which the diftance between the fame radiant point (or imaginary focus) and the centre bears to the diftance between the centre and focus, is equal to the ratio which the fine of the angle of incidence bears to the fine of the angle of refraction.

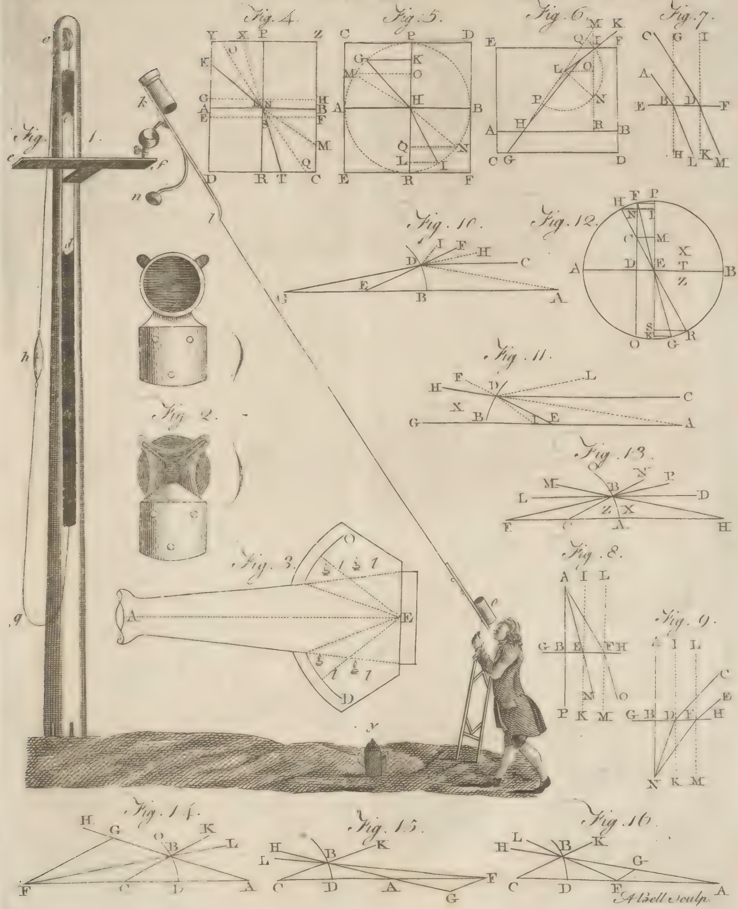
This propofition admits of 16 cafes.

Case 1. Of diverging rays paffing out of a rarer into a denfer medium, thro' a convex furface of the denfer, with fuch a degree of divergency, that they fhall converge after refraction.

Plate CCVIII.

Dem. Let BD (fig. 14.) reprefent a fpherical furface, C its centre of convexity; and let there be two diverging rays AB and AD proceeding from the radiant point A, the one perpendicular to the furface, the other oblique. Thro' the centre C produce the perpendicular one to F; and draw the radius CB, and produce it to K, and let BF be the refracted ray; then will F be the focal point; produce AB to H, and through the point F draw the line FG parallel to CB. AB being the incident ray, and CK perpendicular to the furface at the point B, the angle ABK, or, which is equal to it, becaufe of the parallel lines CB and FG, FGH, is the angle of incidence. Now, whereas, the complement of any angle to two right ones has the fame fine with the angle itfelf, the fine of the angle FGB, that being the complement of FGH to two right ones, may be confidered as the fine of the angle of incidence; which fine the line FB, as the fides of a triangle have the fame relation to each each other that the fines of their oppofite angles have, may be taken for. Again, the angle FBC is the angle of refraction, or its equal, becaufe alternate to it, BFG; to which BG, being an oppofite fide, may be looked upon as the fine. But FB is to BG in a ratio compounded of FB to BA, and of BA to BG; for the ratio that any two quantities bear to each other, is compounded of the ratio which the firft bears to any other, and of the ratio which that other bears to the fecond. Now FB is to BA, fuppofing BD to vanifh, as FD to DA; and BA is to BG, becaufe of the parallel lines CB and FG, as AC to CF. That is, the ratio

OPTICS. Plate CCVIII.



Of Refraction.

ratio compounded of FD the focal diſtance, to DA the diſtance of the radiant point, and of AC, the diſtance between the radiant point and the centre, to CF, the diſtance between the centre and the focus, is equal to that which the fine of the angle of incidence bears to the fine of the angle of refraction. *Q. E. D.*

Plate CCVIII. fig. 14.

Obs. Whereas the focal diſtance of the oblique ray AB is ſuch, that the compound ratio of FB to BA and of AC to CF, ſhall be the ſame, whatever be the diſtance between B and D; it is evident, that ſince AC is always of the ſame length, the more the line AB lengthens, the more FB muſt lengthen too, or elſe FC muſt ſhorten: but it appears by inſpection of the figure, that if BF lengthens, CF will do ſo too, and in a greater proportion with reſpect to its own length than BF will; therefore the lengthening of BF will conduce nothing towards preſerving the equality of the proportion; but as AB lengthens, BF and CF muſt both ſhorten, which is the only poſſible way wherein the proportion may be continued the ſame. And it is alſo apparent, that the farther B moves from D towards O, the faſter AB lengthens; and therefore the farther the rays enter from D, the nearer to the refracting ſurface is the place where they meet, but the ſpace they are collected in is the more diffuſed: and therefore, in this caſe, as well as thoſe taken notice of in the two foregoing obſervatſons, different rays, tho' flowing from the ſame point, ſhall conſtitute different focuſes; and none are ſo effectual as thoſe which enter at, or very near, the point D. And ſince the ſame is obſervable of converging as well as of diverging rays, none except thoſe which enter very near that point are uſually taken into conſideration; upon which account it is, that the diſtance DB, in determining the focal diſtances of diverging or converging rays entering a convex or concave ſurface, is ſuppoſed to vaniſh.

Thoſe who would ſee a method of determining the preciſe point, which the ray AB, whether it be parallel, converging, or diverging to the ray AF, converges to or diverges from after refraction at B or any other given point in the ſurface DO, may find it in the Appendix to Molineux's Optics; which, for the ſake of thoſe who have not the book, we ſhall ſubjoin at the end of this ſection.

Case 2. Of converging rays paſſing out of a rarer into a denſer medium through a concave ſurface of the denſer with ſuch a degree of convergency, that they ſhall diverge after refraction.

Dem. Let the incident rays be HB and FD paſſing out of a rarer into a denſer medium thro' the concave ſurface BD, and tending towards the point A, from whence the diverging rays flowed in the other caſe; then the oblique ray HB, having its angle of incidence HBC equal to ABK the angle of incidence in the former caſe, will be refracted into the line BL, ſuch, that its refracted angle KBL will be equal to FBC the angle of refraction in the former caſe; that is, it will proceed after refraction in the line FB produced, having the ſame focal diſtance FD with the diverging rays AB, AD, in the other caſe. But, by what has been already demonſtrated, the ratio compounded of FD, the focal diſtance, to DA, in this caſe, the diſtance of the imaginary focus of the incident rays, and of AC, the diſtance between the ſame imaginary focus and the centre, to CF, the diſtance between the centre and the focus, is equal to that which the fine of the angle of incidence bears to the fine of the angle of refraction. *Q. E. D.*

Case 3. Of diverging rays paſſing out of a rarer into a denſer medium through a convex ſurface of the denſer with ſuch a degree of divergency as to continue diverging.

Dem. Let AB, AD (fig. 15.) be the diverging rays, and let their divergency be ſo great, that the refracted ray BL ſhall alſo diverge from the other; produce LB back to F, which will be the focal point; draw the radius CB, and produce it to K; produce BA likewiſe towards G, and draw FG parallel to BC. Then will ABK be the angle of incidence, whoſe fine BF may be taken for, as being oppoſite to the angle BGF, which is the complement of the other to two right ones. And LBC is the angle of refraction, or its equal KBF, or, which is equal to this, BFG, as being alternate; therefore BG, the oppoſite ſide to this, may be taken for the fine of the angle of refraction. But BF is to BG, for the like reaſon as was given in caſe the firſt, in a ratio compounded of BF to BA, and of BA to BG. Now BF is to BA, (DB vaniſhing) as DF to DA; and becauſe of the parallel lines FG and BC, the triangles CBA and AGF are ſimilar; therefore BA is to AG as CA to AF; conſequently BA is to BA together with AG, that is, to BG, as CA is to CA together with AF, that is, CF. Therefore the ratio compounded of DF the focal diſtance to DA the diſtance of the radiant point, and of CA the diſtance between the radiant point and the centre, to CF the diſtance between the centre and the focus, is equal to that which the fine of the angle of incidence bears to the fine of the angle of refraction. *Q. E. D.*

Plate CCVIII.

Case 4. Of converging rays paſſing out of a rarer into a denſer medium thro' a concave ſurface of the denſer in ſuch manner that they ſhall continue converging.

Dem. Let HB and CD be the incident rays paſſing out of the rarer into the denſer medium thro' the concave ſurface BD, and tending towards A the ſame point from whence the diverging rays flowed in the laſt Caſe. Then becauſe the ray HB has the ſame inclination to the perpendicular CK that AB had before, it will ſuffer the ſame degree of refraction, and paſs on in the line LB produced, having its focus F at the ſame diſtance from the refracting ſurface as that of the diverging ray AB in the other caſe. Therefore, &c. *Q. E. D.*

Case 5. Of diverging rays paſſing out of a denſer into a rarer medium through a convex ſurface of the denſer.

Dem. Let AB, AD (fig. 16.) be the incident rays paſſing out of a denſer into a rarer medium through the concave ſurface BD whoſe centre is C; and let BL be the refracted ray, which produce back to F, and draw FG parallel to CB. Here ABK is the angle of incidence, to which its alternate one FGB being equal, FB the oppoſite ſide may be conſidered as the fine of it. The angle of refraction is LBC or FBK; of which BFG being the complement to two right ones, BG the oppoſite ſide may be looked upon as its fine. But BF is to BG, in the com-

Of Refraction.

compound ratio of BF to BA, and of BA to BG, for the reason given above. Now (BD vanishing) BF is to BA as DF to DA, and BA is to BG as CA to CF; that is, the ratio compounded of the focal distance to the distance of the radiant point, &c. *Q. E. D.*

Case 6. Of converging rays passing out of a denser into a rarer medium through a concave surface of the denser.

Dem. Let HB, CD, be the incident rays tending towards the point A which was the radiant in the last Case. Then, for the reason already given, the oblique ray will suffer such a degree of refraction, as to have its focus F at the same distance from the surface, as the diverging rays AB, AD, had in that case. Therefore, &c. *Q. E. D.*

When the mediums through which rays pass, and the refracting surfaces are such, that rays flowing from
Plate CCVIII.
A (fig. 14.) are collected in F, then rays flowing from F through the same mediums the contrary way, will be collected in A. For when rays pass out of one medium into another, the sine of the angle of incidence bears the same proportion to the sine of the angle of refraction, as the sine of the angle of refraction does to the sine of the angle of incidence, when they pass the contrary way. This is applicable to each of the six following Cases compared respectively with the six foregoing: therefore they may be considered as the converse of them; or they may be demonstrated independently of them, as follows.

Case 7. Of diverging rays passing out of a denser into a rarer medium through a concave surface of the denser, so as to converge afterwards.

Plate CCIX.
Dem. Let AB, AD (fig. 1.) be two diverging rays passing thro' the concave surface BD into a rarer medium. Let C be the centre of concavity, and BF the refracted ray. Draw CB, and produce it to K; and draw FG parallel to it, meeting AB produced in G. Then will ABC be the angle of incidence; of which FB being opposite to its alternate and equal angle FGB, may be considered as the sine. The angle of refraction is FBK; of which GB, being opposite to its complement to two right ones GFB, may be taken for the sine. Now FB is to BG in a ratio compounded of FB to BA, and of BA to BG. But (BD vanishing) FB is to BA as FD to DA; and because of the parallel lines CB and FG, BA is to BG as CA to CF. Therefore the focal distance, &c. *Q. E. D.*

Case 8. Of converging rays passing out of a denser into a rarer medium thro' a convex surface of the denser, so as to diverge afterwards.

Dem. Let GB and FD be the incident rays tending towards A, and produce FB to L. Then as AB in the last Case was refracted into BF, GB will in this be refracted into BL, for the reasons already given, having F for its focal point. Therefore, &c. *Q. E. D.*

Case. 9. Of diverging rays passing out of a denser into a rarer medium thro' a concave surface of the denser, in such a manner as to continue diverging.

Dem. Let AB, AD (fig. 2.) be two rays passing out of a denser into a rarer medium, through the concave surface DB, whose centre of concavity is C. Draw CB, produce it to K, and let BL be the refracted ray; produce BL back to F, and draw FG parallel to CB meeting BC produced in G. Then will ABC be the angle of incidence, of which FB being opposite to its alternative and equal angle FGB, may be considered as the sine. The refracted angle is LBK, or its equal CBF; of which BG, being opposite to its complement to two right ones BFG, is the sine. Now BF is to BG in the compound ratio of BF to BA and of BA to BG: but BF is to BA as DF to DA; and because of the parallel lines CB and FG, the triangles BCA, AGF, are similar: therefore BA is to AG as CA to AF, and consequently BA is to BG as CA to CF. Therefore, &c. *Q. E. D.*

Case 10. Of converging rays passing out of a denser into a rarer medium through a convex surface of the denser, in such manner as to continue converging.

Dem. Let HB, MD, be the incident rays tending towards the point A. Then will the oblique ray HB, for the reasons already given, be refracted in BF. Therefore, &c. *Q. E. D.*

Case 11. Of diverging rays passing out of a rarer into a denser medium through a concave surface of the denser.

Dem. Let AB, AD (fig. 3.) be the incident rays passing out of a rarer into a denser medium, through the concave surface BD, whose centre of convexity is C, and supposing the line CB drawn and produced to K, the refracted ray BL drawn and produced back to F, and also FG drawn parallel to CB, ABC will be the angle of incidence; of which FB, being opposite to its complement to two right ones BGF, is the sine. The angle of refraction will be LBK, or its equal FBC; of which BG, being opposite to its equal and alternate one BFG, is the sine. Now FB is to BG in the compound ratio of FB to BA and of BA to BG. But (BD vanishing) FB is to BA as FD to DA, and because of the parallel line FG and CB, BA is to BG as CA to CF. Therefore, &c. *Q. E. D.*

Case 12. Of converging rays passing out of a rarer into a denser medium through a convex surface of the denser.

Dem. Let HB, MD, be the incident rays tending towards A the radiant point in the last case; then, as was explained above, BF will be the refracted ray. Therefore, &c. *Q. E. D.*

Case 13. Of rays passing out of a rarer into a denser medium from a point between the centre of convexity and the surface.

Dem. Let AB, AD (fig. 4.) be two rays passing out of a rarer into a denser medium from the point A, which let be posited between C the centre of convexity and the refracting surface BD; through B draw CK, and let BL be the refracted ray; produce BL back to F, and draw FG parallel to BC. Then will ABC be the angle of incidence; of which BF, being opposite to its complement to two right ones BGF, is the sine. LBK will be the angle of refraction, or its equal FBC; of which BG, being opposite to its alternate and equal one BFG, is the sine. But, as before, BF is to BG in a compound ratio of BF to BA and of BA to BG; and (BD vanishing) BF is to BA as DF to DA, and because the lines CB and FG are pa-

Of Refraction. parallel, BA is to BG as CA to CF. Therefore, &c. *Q. E. D.*

CASE 14. Of rays paffing out of a denfer into a rarer medium towards a point between the centre of convexity and the furface.

DEM. Let the incident rays be MD, HB, tending towards A, from whence the other proceeded in the laft cafe. Then, as in that cafe the refracted ray BL being produced back paffed through F, in this the refracted ray itfelf, for the like reafons as were given in the foregoing cafes, will pafs through that point. Therefore, &c. *Q. E. D.*

CASE 15. Of rays paffing out of a rarer into a denfer medium from a point between the centre of convexity and the furface.

Plate CCIX. DEM. Let AB, AD (fig. 5.) be two diverging rays paffing out of a denfer into a rarer medium thro' the refracting furface BD, whofe centre of convexity is C, a point beyond that from whence the rays flow. Through B draw CK, and let BL be the refracted ray; produce it back to F, and draw FG parallel to BC, meeting BA produced in G. ABC will be the angle of incidence; of which BF, being oppofite to its alternate and equal angle BGF, is the fine. The angle of refraction is LBK, or its equal FBC; of which BG, being oppofite to its complement to two right ones BFG, is the fine. But BF is to BG in the compound ratio of BF to BA and of BA to BG; and (BD vanifhing) BF is to BA as DF to DA; and becaufe of the parallel lines CB and GF, the triangles AFG and ABC are fimilar. BA therefore is to AG, as CA to AF; confequently BA is to BA and AG together, that is, to BG, as CA is to CA and AF together, that is, to CF; and therefore the focal diftance, &c. *Q. E. D.*

CASE 16. Of rays paffing out of a denfer into a rarer medium towards a point between the centre of convexity and the furface.

DEM. Let HB, MD, be the incident rays having for their imaginary focus the point A, which was the radiant in the laft cafe; and let C the centre of convexity of the refracting furface be pofited beyond this point. Then will HB, for the reafons already given, be refracted into BF, having the point F for its real focus, which was the imaginary one of the diverging rays AB, AD, in the former cafe. Therefore, as before, the ratio compounded of that which the focal diftance bears to the diftance of the imaginary focus of the incident rays, and of that which the diftance between the fame imaginary focus and the centre bears to the diftance between the centre and the focus, is equal to the ratio which the fine of the angle of incidence bears to the fine of the angle of refraction. *Q. E. D.*

The firft term in the foregoing proportion (viz. that in propofition 3d) being always an unknown quantity, thofe who are not well verfed in the ufe of fuch propofitions, may think it impoffible to inveftigate the focal diftance of any refracting furface by it, we fhall therefore exemplify in the following inftance, by which the manner of doing it in all others will clearly be underftood. *V. g.* Let it be required to determine the focal diftance of diverging rays paffing out of air into glafs through a convex furface; and let the diftance of the radiant point be 20, and the radius of convexity be 5: now, becaufe we muft make ufe of the focal diftance before we know it, let that be expreffed by fome fymbol or character as x: Then, becaufe by the aforefaid propofition the ratio compounded of that which the focal diftance bears to the diftance of the radiant point (that is, in this fuppofition, of x to 20), and of the ratio which the diftance of the fame radiant point from the centre bears to the diftance between the centre and the focus (in this cafe, of 25 to $x-5$), is equal to the ratio which the fine of the angle of incidence bears to the fine of the angle of refraction (that is, of 17 to 11), we fhall have, in the inftance before us, the following proportion, viz.

$$\left.\begin{array}{l} x : 20 \\ 25 : x-5 \end{array}\right\} : : 17 : 11;$$

and compounding them into one, which is done by multiplying the two firft parts together, we have $25x : 20x-100 : : 17 : 11$, and multiplying the extreme terms and middle terms together $340x-1700=275x$, which equation after due reduction gives $x=\frac{1700}{65}$.

In fome cafes which might have been put, the quantity 65 would have been negative; and then the quotient arifing from 1700, divided by that, would have been fo too: that is, x the focal diftance would have been negative; in which cafe, the focus muft have been taken on the contrary fide of the furface to that on which it was fuppofed to fall in ftating the problem; that is, it muft have been taken on the fame fide with the radiant point; for in calling the diftance between the centre and the focus $x-5$, it was fuppofed the focus would fall on the fame fide with the centre, or on that which is oppofite to the radiant point; becaufe otherwife that diftance muft have been expreffed by $x+5$; as any one may fee by infpection of the 13th or 14th figure, in which the focus of diverging rays entering a convex furface, is fuppofed to fall on the fame fide with the radiant point.

In like manner as this problem was performed, a general theorem may be raifed to folve it in all cafes whatfoever, by ufing characters inftead of figures; as every one who is not unacquainted with algebraic operations very well knows.

See this done, and applied to the paffage of rays through the furface of lenfes, in the following fection.

A method of determining the point which a ray, entering a fpherical furface at any given diftance from the vortex of it, converges to, or diverges from, after refraction at the fame. *From the Appendix to Molineux's Dioptrics.*

" PROP. To find the focus of any parcel of rays diverging from, or converging to, a given point in the axis of a fpherical lens [furface], and inclined thereto under the fame angle; the ratio of the fines in refraction being known.

" Let GL (fig. 6.) be the lens, P any point in its furface, V the pole [vertex] thereof, C the centre of the fphere whereof it is a fegment, O the object or point in the axis to or from which the rays do proceed, OP a given ray; and let the ratio of refraction be as r to s; make CR to CO as s to r for the immerfion of a ray, or as r to s for the emerfion, (that is, as the fines of the angles in the medium which the ray

Of Refraction.

ray enters, to their correſponding ſines in the medium out of which it comes); and laying CR from C towards O, the point R ſhall be the ſame for all the rays of the point O. Then draw the radius PC (if need be) continued, and with the centre R and diſtance OP ſweep a touch of an arch, interſecting PC in Q; the line QR being drawn ſhall be parallel to the refracted ray, and PF being made parallel thereto ſhall interſect the axis in the point F; which is the focus ſought. Or make it as CQ : CP : : CR : CF, and CF ſhall be the diſtance of the focus from the centre of the ſphere.

"Dem. Let fall the perpendiculars PX on the axis, CY on the given ray, and CZ on the refracted ray. By the conſtruction QF and PR are parallel, whence the triangles QRC and PFC are ſimilar, and CR to QR, as CF to PF; that is, CR to OP, as CF to PF. Now CF : PF : : CZ : PX *ob ſimilia triang.*; whence CR : OP : : CZ : PX, and CR : CZ : : OP : PX. Again, CR is to CO as the ſines of refraction by conſtruction; that is, as s to r, or r to s; and as CR to CZ, ſo (CO=) $\frac{r}{s}$ or $\frac{s}{r}$CR to $\frac{r}{s}$ or $\frac{s}{r}$CZ; and ſo is PO to PX: But as PO to PX, ſo CO to CY. *Ergo*, CY= $\frac{r}{s}$ or $\frac{s}{r}$CZ; that is, CY to CZ is as the ſines of refraction; but CY is the ſine of the angle of incidence, and CZ of the refracted angle. *Ergo conſtat propoſitio.*——

"Hitherto we have conſidered only oblique rays; it now remains to add ſomething concerning rays parallel to the axis: in this caſe the point O muſt be conſidered as infinitely diſtant, and conſequently OP, OC, and CR are all infinite: and OP and OC are in this caſe to be accounted as always equal, (ſince they differ but by a part of the radius of the ſphere GPVL, which is no part of either of them): wherefore the ratio of CR to OP will be always the ſame, *viz.* as s to r for immerging rays, and as r to s for thoſe that emerge. And by this propoſition CF is to PF in the ſame ratio. It remains therefore to ſhew on the baſe CP how to find all the triangles CPF, wherein CF is to PF in the ratio given by the degree of refraction. This problem has been very fully conſidered by the celebrated Dr Wallis in his late treatiſe of Algebra, p. 258, to which we refer; but we ſhall here repeat the conſtruction thereof. (See fig. 7. 8.)

Plate CCIX.

"Let GPVL be a lens, VC or PC the radius of its ſphere, and let it be required to find all the points f, f, ſuch as Cf may be to Pf in the given ratio of s to r for immerging rays, or as r to s for the emerging. Divide CV in K, and continue CV to F, that CK may be to VK, and CF to VF, in the propoſed ratio. Then divide KF equally in the point a, and with that centre ſweep the circle FKF; this circle being drawn, gives readily all the foci of the parallel rays OP, OP. For having continued CP till it interſect the circle in F, PF ſhall be always equal to Vf, the diſtance of the focus of each reſpective parcel of rays OP from the vertex or pole of the lens.

"To demonſtrate this, draw the pricked line VF, and by what is delivered by Dr Wallis in the above-cited place, VF and CF will be always in the ſame propoſed ratio. Again, Vf being made equal to PF, CF and Cf will be likewiſe equal, as are CP, VC; and the angles PCf, VCF, being *ad verticem*, are alſo equal: Wherefore Pf will be equal to VF, and conſequently Cf to Pf in the ſame ratio as CF to VF; whence, and by what foregoes, the points f, f, are the ſeveral reſpective foci of the ſeveral parcels of rays OP, OP. *Q. E. D.*

Of Refraction.

§ 2. *Of Glaſſes.*

Glass may be ground into eight different ſhapes at leaſt, for optical purpoſes, *viz.*

1. A *plane-glaſs*, which is flat on both ſides, and of equal thickneſs in all its parts, as A. Fig. 9.
2. A *plano-convex*, which is flat on one ſide, and convex on the other, as B.
3. A *double-convex*, which is convex on both ſides, as C.
4. A *plano-concave*, which is flat on one ſide, and concave on the other, as D.
5. A *double concave*, which is concave on both ſides, as E.
6. A *meniſcus*, which is concave on one ſide, and convex on the other, as F.
7. A *flat plano-convex*, whoſe convex ſide is ground into ſeveral little flat ſurfaces, as G.
8. A *priſm*, which has three flat ſides, and when viewed endwiſe appears like an equilateral triangle, as H.

Glaſſes ground into any of the ſhapes B, C, D, E, F, are generally called *lenſes*.

A right line LIK, (fig. 9.) going perpendicularly through the middle of a lens, is called the *axis of the lens*.

A ray of light Gh, (fig. 10.) falling perpendicularly on a plane glaſs EF, will paſs thro' the glaſs in the ſame direction $h\,i$, and go out of it into the air in the ſame right courſe iH.

A ray of light AB, falling obliquely on a plane glaſs, will go out of the glaſs in the ſame direction, but not in the ſame right line: for in touching the glaſs, it will be refracted in the line BC; and in leaving the glaſs, it will be refracted in the line CD.

A ray of light CD, (fig. 11.) falling obliquely on the middle of a convex glaſs, it will go forward in the ſame direction DE, as if it had fallen with the ſame degree of obliquity on a plane glaſs; and will go out of the glaſs in the ſame direction with which it entered: for it will be equally refracted at the points D and E, as if it had paſſed through a plane ſurface. But the rays CG and CI will be ſo refracted, as to meet again at the point F. Therefore, all the rays which flow from the point C, ſo as to go through the glaſs, will meet again at F; and if they go farther onward, as to L, they croſs at F, and go forward on the oppoſite ſides of the middle ray CDEF, to what they were in approaching it in the directions HF and KF.

When parallel rays, as ABC, (fig. 12.) fall directly upon a plano-convex glaſs DE, and paſs through it, they will be ſo refracted, as to unite in a point f behind it: and this point is called the *principal focus*; the diſtance of which, from the middle of the glaſs, is called the *focal diſtance*, which is equal to twice the radius of the ſphere of the glaſs's convexity. And,

When parallel rays, as ABC, (fig. 13.) fall directly upon

Of Refraction.

Plate CCIX.

upon a glaſs DE, which is equally convex on both ſides, and paſs through it; they will be ſo refracted, as to meet in a point or principal focus f, whoſe diſtance is equal to the radius or ſemidiameter of the ſphere of the glaſs's convexity. But if a glaſs be more convex on one ſide than one the other, the rule for finding the focal diſtance is this: As the ſum of the ſemidiameters of both convexities is to the ſemidiameter of either, ſo is double the ſemidiameter of the other to the diſtance of the focus. Or divide the double product of the radii by their ſum, and the quotient will be the diſtance ſought.

Since all thoſe rays of the ſun which paſs through a convex glaſs are collected together in its focus, the force of all their heat is collected into that part; and is in proportion to the common heat of the ſun, as the area of the glaſs is to the area of the focus. Hence we ſee the reaſon why a convex glaſs cauſes the ſun's rays to burn after paſſing through it.

All theſe rays croſs the middle ray in the focus f, and then diverge from it, to the contrary ſides, in the ſame manner FfG, as they converged in the ſpace DfE in coming to it.

If another glaſs FG, of the ſame convexity as DE, be placed in the rays at the ſame diſtance from the focus, it will refract them ſo, as that, after going out of it, they will be all parallel, as *a b c;* and go on in the ſame manner as they came to the firſt glas DE, thro' the ſpace ABC; but on the contrary ſides of the middle ray Bfb: for the ray ADf will go on from f in the direction fGa, and the ray CEf in the direction fFc; and ſo of the reſt.

The rays diverge from any radiant point, as from a principal focus: Therefore if a candle be placed at f, in the focus of the convex glaſs FG, the diverging rays in the ſpace FfG will be ſo refracted by the glaſs, as that, after going out of it, they will become parallel, as ſhewn in the ſpace *c b a*.

If the candle be placed nearer the glaſs than its focal diſtance, the rays will diverge after paſſing thro' the glaſs more or leſs as the candle is more or leſs diſtant from the focus.

If the candle be placed farther from the glaſs than its focal diſtance, the rays will converge after paſſing thro' the glaſs, and meet in a point, which will be more or leſs diſtant from the glaſs as the candle is nearer to or farther from its focus: and where the rays meet, they will form an inverted image of the flame of the candle; which may be ſeen on a paper placed in the meeting of the rays.

Hence, if any object ABC (fig. 15.) be placed beyond the focus F of the convex glaſs *d e f*, ſome of the rays which flow from every point of the object, on the ſide next the glaſs, will fall upon it; and after paſſing through it, they will be converged into as many points on the oppoſite ſide of the glaſs, where the image of every point will be formed, and conſequently the image of the whole object, which will be inverted. Thus, the rays Ad, Ae, Af, flowing from the point A, will converge in the ſpace *d a f*, and by meeting at a, will there form the image of the point A. The rays Bb, Be, Bf, flowing from the point B, will be united at b by the refraction of the glaſs, and will there form the image of the point B. And the rays Cd, Ce, Cf, flowing from the point C, will be united at c, where they will form the image of the point C. And ſo of all the other intermediate points between A and C. The rays which flow from every particular point of the object, and are united again by the glaſs, are called *pencils of rays*.

Of Refraction.

If the object ABC be brought nearer to the glaſs, the picture *a b c* will be removed to a greater diſtance. For then more rays flowing from every ſingle point, will fall more diverging upon the glaſs; and therefore cannot be ſo ſoon collected into the correſponding points behind it. Conſequently, if the diſtance of the object ABC (fig. 16.) be equal to the diſtance eB of the focus of the glaſs, the rays of each pencil will be ſo refracted by paſſing through the glaſs, that they will go out of it parallel to each other; as dI, eH, fh, from the point C; dG, eK, fD, from the point B; and dK, eE, fL, from the point A: and therefore, there will be no picture formed behind the glaſs.

If the focal diſtance of the glaſs, and the diſtance of the object from the glaſs, be known, the diſtance of the picture from the glaſs may be found by this rule, viz. Multiply the diſtance of the focus by the diſtance of the object, and divide the product by their difference; the quotient will be the diſtance of the picture.

The picture will be as much bigger or leſs than the object, as its diſtance from the glaſs is greater or leſs than the diſtance of the object. For, as Be (fig. 15.) is to eB, ſo is AC to ca. So that if ABC be the object, *c b a* will be the picture; or if *c b a* be the object, ABC will be the picture. 114

How to find the focus of any lens.

For determining the progreſs of the rays after refraction by any lens, whatever be its form or matter, Mr Rowning gives the following method. "Suppoſe GH (fig. 14.) to be a given lens, and E a point in its axis from whence the diverging rays EL, &c. fall upon the lens, AL, the radius of the firſt convexity, and CK that of the ſecond; let LKf be the direction of the diverging ray EL after its refraction at the firſt ſurface, and KF its direction after refraction at both. Then will f be the focus of the rays after their firſt refraction, and F the point they will meet in after both. Let BD be the thickneſs of the lens, and let the proportion which the ſine of the angle of incidence bears to the ſine of the angle of refraction be expreſſed by the ratio of I to R. Call EB, d; BD, t; AB, r; CD, s; Bf, x; DF, y: Now, to find f their focus after refraction at L where they enter the firſt ſurface of the lens, comes under the third propoſition abovementioned: according to which the ratio compounded of x, the focal diſtance ſought, to d, the diſtance of the radiant point; and of $d+r$, the diſtance between the ſame point and the centre, to $x-r$, the diſtance between the centre and the focus, is as I to R; compounding theſe two ratios therefore (that is, multiplying them together) we have $dx+rx : dx-dr :: \mathrm{I} : \mathrm{R}$; which proportion being converted into an equation, and duly reduced, gives $x=\frac{\mathrm{I}dr}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r}$.

Thus having found the diſtance Bf, and conſequently the point f, to which the rays converge from L, we muſt proceed to find F, that to which they will converge after having paſſed through K, where they ſuffer a

a second refraction: this comes under the same proposition. But, if we would use the same letters as before, to express the proportion which the sine of the angle of incidence bears to that of the angle of refraction, they must be put one for the other; because, when rays pass out of a denser into a rarer medium, the sine of the angle of incidence bears the same proportion to the sine of the angle of refraction, that the sine of the angle of refraction does to the sine of the angle of incidence, when they pass out of a rarer into a denser. This being observed, by the aforesaid proposition, we shall have the ratio compounded of y, the focal distance, to $\frac{\mathrm{I}dr}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r}-t$, the imaginary focus in the incident rays, and of $\frac{\mathrm{I}dr}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r}-t+s$, the distance between the imaginary focus and the centre, to $y+s$, the distance between the centre and the focus, as R to I. Which equation, if we reduce the mixed quantities $\frac{\mathrm{I}dr}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r}-t$, and $\frac{\mathrm{I}dr}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r}-t+s$, into improper fractions, will stand thus:

$$\left.\begin{array}{c} y : \dfrac{\mathrm{I}dr-\mathrm{I}dt+\mathrm{R}dt+\mathrm{R}rt}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r} \\ \text{and} \\ \dfrac{\mathrm{I}dr-\mathrm{I}dt+\mathrm{R}dt+\mathrm{R}rt+\mathrm{I}ds-\mathrm{R}ds-\mathrm{R}rs}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r} : y+s \end{array}\right\} :: \mathrm{R} : \mathrm{I}.$$

And, compounding these ratios, we have

$$\frac{\mathrm{I}dry-\mathrm{I}dty+\mathrm{R}dty+\mathrm{R}rty+\mathrm{I}dsy+\mathrm{R}dsy-\mathrm{R}rsy}{\mathrm{I}d-\mathrm{R}d-\mathrm{R}r} : \frac{\mathrm{I}dry-\mathrm{I}dty+\mathrm{R}dty+\mathrm{R}rty+\mathrm{I}drs-\mathrm{I}dts-\mathrm{R}dts+\mathrm{R}rts}{-\mathrm{R}r} :: \mathrm{R} : \mathrm{I}.$$

And throwing out the two equal denominartors $\mathrm{I}d-\mathrm{R}d-\mathrm{R}r$, and $\mathrm{I}d-\mathrm{R}d-\mathrm{R}r$, and multiplying extremes together and means together, we have $\mathrm{II}dry-\mathrm{II}dty+\mathrm{IR}dty+\mathrm{IR}rty+\mathrm{II}dsy-\mathrm{IR}dsy-\mathrm{IR}rsy=\mathrm{IR}dry-\mathrm{IR}dty+\mathrm{RR}dty+\mathrm{RR}rty+\mathrm{IR}drs-\mathrm{IR}dts+\mathrm{RR}dts+\mathrm{RR}rts$; which equation being reduced, gives

$$y=\frac{\mathrm{IR}drs-\mathrm{IR}dts+\mathrm{RR}dts+\mathrm{RR}rts}{\mathrm{II}dr-\mathrm{II}dt+\mathrm{I}2\mathrm{R}dt+\mathrm{IR}rt+\mathrm{II}ds-\mathrm{IR}ds-\mathrm{IR}rs-\mathrm{IR}dr-\mathrm{RR}dt-\mathrm{RR}rt}.$$

This theorem may be applied to all cases whatever; even to plane surfaces *mutatis mutandis*, *v. g.* the radius of a concave surface being negative (as lying the contrary way) with respect to that of a convex, and the radius of a plain surface being an infinite line. If we would apply this theorem to a concave surface, we must change all the signs of those members wherein the symbol expressing the radius of that surface occurs; and if to a plane surface, all the members which involve the radius must be considered as infinite quantities: that is, all, except them, must be struck out of the equation as nothing. So, likewise, if we would have it extend to other rays besides diverging ones, the point where converging rays would meet, lying on the contrary side to that from whence the diverging ones were supposed to flow, its distance must be made negative; and the distance where parallel rays meet being infinite, it is only changing the signs of all those members in which d is found, if the rays are supposed converging; or making those members infinite, in case the rays are supposed parallel; which is done by striking out all the rest, as bearing no proportion to them.

§ 3. *Of Vision.*

Having described how the rays of light, flowing from objects, and passing through convex glasses, are collected into points, and form the images of the objects; it will be easy to understand how the rays are affected by passing through the humours of the eye, and are thereby collected into innumerable points on the bottom of the eye, and thereon form the images of the objects which they flow from. For, the different humours of the eye, and particularly the crystalline humour, are to be considered as a convex glass; and the rays in passing through them to be affected in the same manner as in passing through a convex glass. A description of the coats and humours, &c. has been given at large in anatomy: but for the reader's convenience in this place, we shall repeat in a few words as much of the description as will be sufficient for our present purpose.

The eye is nearly globular. It consists of three coats and three humours. The part DHHG of the outer coat, is called the *sclerotica;* the rest, DEFG, the *cornea*. Next within this coat is that called the *choroides*, which serves as it were for a lining to the other, and joins with the iris, *mn*, *mn*. The iris is composed of two sets of muscular fibres; the one of a circular form, which contracts the hole in the middle called the *pupil*, when the light would otherwise be too strong for the eye; and the other of radial fibres, tending every where from the circumference of the iris towards the middle of the pupil; which fibres, by their contraction, dilate and enlarge the pupil when the light is weak, in order to let in the more of its rays. The third coat is only a fine expansion of the optic nerve L, which spreads like net-work all over the inside of the choroides, and is therefore called the *retina;* upon which are painted (as it were) the images of all visible objects, by the rays of light which either flow or are reflected from them. Plate CCX. fig. 1. 115 Description of the eye.

Under the cornea is a fine transparent fluid like water, which is therefore called the *aqueous humour*. It gives a protuberant figure to the cornea, fills the two cavities *mm* and *nn*, which communicate by the pupil P; and has the same limpidity, specific gravity, and refractive power, as water. At the back of this lies the crystalline humour II, which is shaped like a double convex glass; and is a little more convex on the back than the fore part. It converges the rays, which pass through it from every visible object to its focus at the bottom of the eye. This humour is transparent like crystal, is much of the consistence of hard jelly, and exceeds the specific gravity of water in the proportion of 11 to 10. It is inclosed in a fine transparent membrane, from which proceed radial fibres *oo*, called the *ligamentum ciliare*, all around its edge; and join to the circumference of the iris.

At the back of the crystalline, lies the vitreous humour KK, which is transparent like glass, and is largest of all in quantity, filling the whole orb of the eye, and giving it a globular shape. It is much of a consistence with the white of an egg, and very little exceeds the specific gravity and refractive power of water.

As every point of an object ABC, (*ibid.*) sends out

Of Refraction.

out rays in all directions, some rays, from every point on the side next the eye, will fall upon the cornea between E and F; and by passing on thro' the humours and pupil of the eye, they will be converged to as many points on the retina or bottom of the eye, and will thereon form a distinct inverted picture *c b a* of the object. Thus, the pencil of rays *q r s* that flows from the point A of the object, will be converged to the point *a* on the retina; those from the point B will be converged to the point *b*; those from the point C will be converged to the point *c*; and so of all the intermediate points; by which means the whole image *a b c* is formed, and the object made visible: altho' it must be owned, that the method by which this sensation is carried from the eye by the optic nerve to the common sensory in the brain, and there discerned, is above the reach of our comprehension.

But that vision is effected in this manner, may be demonstrated experimentally. Take a bullock's eye whilst it is fresh; and having cut off the three coats from the back part, quite to the vitreous humour, put a piece of white paper over that part, and hold the eye towards any bright object, and you will see an inverted picture of the object upon the paper.

116 Why we see objects upright.

Since the image is inverted, many have wondered why the object appears upright. But we are to consider, 1. That inverted is only a relative term: and, 2. That there is a very great difference between the real object and the means or image by which we perceive it. When all the parts of a distant prospect are painted upon the retina, they are all right with respect to one another, as well as the parts of the prospect itself; and we can only judge of an object's being inverted, when it is turned reverse to its natural position with respect to other objects which we see and compare it with.—If we lay hold of an upright stick in the dark, we can tell which is the upper or lower part of it, by moving our hand downward or upward; and know very well that we cannot feel the upper end by moving our hand downward. Just so we find by experience, that upon directing our eyes towards a tall object, we cannot see its top by turning our eyes downward, nor its foot by turning our eyes upward; but must trace the object the same way by the eye to see it from head to foot, as we do by the hand to feel it; and as the judgment is informed by the motion of the hand in one case, so it is also by the motion of the eye in the other.

Plate CCX.

In fig. 2. is exhibited the manner of seeing the same object ABC, by both the eyes D and E at once.

117 Optic nerve insensible of light.

When any part of the image *cba* falls upon the optic nerve L, the corresponding part of the object becomes invisible. On which account, nature has wisely placed the optic nerve of each eye, not in the middle of the bottom of the eye, but towards the side next the nose; so that whatever part of the image falls upon the optic nerve of one eye, may not fall upon the optic nerve of the other. Thus the point *a* of the image *c b a* falls upon the optic nerve of the eye D, but not of the eye E; and the point *c* falls upon the optic nerve of the eye E, but not of the eye D: and therefore, to both eyes taken together, the whole object ABC is visible.

The nearer that any object is to the eye, the larger is the angle under which it is seen, and the magnitude under which it appears. Thus to the eye D, (fig. 3.) the object ABC is seen under the angle APC; and its image *c b a* is very large upon the retina: but to the eye E, at a double distance, the same object is seen under the angle A*p*C, which is equal only to half the angle APC, as is evident by the figure. The image *c b a* is likewise twice as large in the eye D, as the other image *c b a* is in the eye E. In both these representations, a part of the image falls on the optic nerve, and the object in the corresponding part is invisible.

As the sense of seeing is allowed to be occasioned by the impulse of the rays from the visible object upon the retina of the eye, and forming the image of the object thereon, and that the retina is only the expansion of the optic nerve all over the choroides; it should seem surprising, that the part of the image which falls on the optic nerve should render the like part of the object invisible; especially as that nerve is allowed to be the instrument by which the impulse and image are conveyed to the common-sensory in the brain.

118 Proved by experiment.

That the part of the image which falls upon the middle of the optic nerve is lost, and consequently the corresponding part of the object is rendered invisible, is plain by experiment. For if a person fixes three patches, A, B, C, (fig. 4.) upon a white wall, at the height of the eye, and the distance of about a foot from each other, and places himself before them, shutting the right eye, and directing the left towards the patch C, he will see the patches A and C, but the middle patch B will disappear. Or, if he shuts his left eye, and directs the right towards A, he will see both A and C, but B will disappear; and if he directs his eye towards B, he will see both B and A, but not C. For whatever patch is directly opposite to the optic nerve N, vanishes. This requires a little practice, after which he will find it easy to direct his eye so as to lose the sight of whichever patch he pleases.

119 Dispute concerning the seat of vision.

This experiment, first tried by M. Mariotte, occasioned a new hypothesis concerning the seat of vision, which he supposed not to be in the retina, but in the choroides. An improvement was afterwards made upon it by M. Picard, who contrived that an object should disappear when both the eyes were kept open. He fastened upon a wall a round white paper, an inch or two in diameter; and by the side of it he fixed two marks, one on the right hand, and the other on the left, each at about 2 feet distance from the paper, and somewhat higher. He then placed himself directly before the paper, at the distance of 9 or 10 feet, and putting the end of his finger over against both his eyes, so that the left-hand mark might be hid from the right eye, and the right-hand mark from the left eye. Remaining firm in this posture, and looking steadily, with both eyes, on the end of his finger, the paper which was not at all covered by it would totally disappear. This, he says, is the more surprising, because, without this particular encounter of the optic nerves, where no vision is made, the paper will appear double, as is the case when the finger is not rightly placed.

M. Marriotte observes, that this improvement on his

his experiment, by M. Picard, is ingenious, but difficult to execute, since the eyes must be considerably strained in looking at any object so near to them as four inches; and proposes another not less surprising, and more easy. Place, says he, on a dark ground, two round pieces of white paper, at the same height, and three feet from one another; then place yourself opposite to them, at the distance of 12 or 13 feet, and hold your thumb before your eyes, at the distance of about eight inches, so that it may conceal from the right eye the paper that is to the left hand, and from the left eye the paper to the right hand. Then, if you look at your thumb steadily with both eyes, you will lose sight of both the papers; the eyes being so disposed, that each of them receives the image of one of the papers upon the base of the optic nerve, while the other is intercepted by the thumb.

M. Le Cat pursued this curious experiment a little farther than M. Marriotte had done. In the place of the second paper, he fixed a large white board, and observed, that at a proper distance he lost sight of a circular space in the centre of it. He also observed the size of the paper which is thus concealed from the sight, corresponding to several distances, which enabled him to ascertain several circumstances relating to this part of the structure of the eye more exactly than had been done before.

The manner in which this curious experiment is now generally made, and which is both the easiest with respect to the eye, and the most indisputable with respect to the fact, is the following. Let three pieces of paper be fastened upon the side of a room, about two feet asunder; and let a person place himself opposite to the middle paper, and, beginning near to it, retire gradually backwards, all the while keeping one of his eyes shut, and the other turned obliquely towards that outside paper which is towards the covered eye, and he will find a situation (which is generally at about five times the distance at which the papers are placed from one another), where the middle paper will entirely disappear, while the two outermost continue plainly visible; because the rays which come from the middle paper will fall upon the retina where the optic nerve is inserted.

It will not surprise any person, even those who are the strongest advocates for the retina being the place at which the pencils of rays are terminated, and consequently the proper seat of vision, that M. Mariotte was led by this remarkable observation to suspect the contrary. He not only did so; but, in consequence of attentively considering the subject, a variety of other arguments in favour of the choroides occurred to him, particularly his observation, that the retina is transparent, as well as the crystalline, and other humours of the eye, which he thought could only enable it to transmit the rays farther; and he could not persuade himself that any substance could be considered as being the termination of the pencils, and the proper seat of vision, at which the rays are not stopped in their progress.

He was farther confirmed in his opinion of the small degree of sensibility in the retina, and of the greater sensibility of the choroides, by observing that the pupil dilates itself in the shade, and contracts itself in a great light; which involuntary motion, he thought, was a clear proof that the fibres of the iris are extremely sensible to the action of light; and this part of the eye is only a continuation of the choroides (A). He also thought that the dark colour of the choroides was intended to make it more susceptible of the impression of light.

M. Pecquet, in answer to M. Mariotte's observation concerning the transparency of the retina, says, that it is very imperfectly so, resembling only oiled paper, or the horn that is used for lanterns; and besides, that its whiteness demonstrates it to be sufficiently opaque for stopping the rays of light, as much as is necessary for the purpose of vision; whereas, if vision be performed by means of those rays which are transmitted through such a substance as the retina, it must be very indistinct.

As to the blackness of the choroides, which M. Marriotte thought to be necessary for the purpose of vision, M. Pecquet observes, that it is not the same in all eyes, and that there are very different shades of it among the individuals of mankind, as also among birds, and some other animals, whose choroides is generally black; and that in the eyes of lions, camels, bears oxen, stags, sheep, dogs, cats, and many other animals, that part of the choroides which is the most exposed to light, very often exhibits colours as vivid as those of mother of pearl, or of the iris. He admits that there is a defect of vision at the insertion of the optic nerve; but he thought that it was owing to the blood-vessels of the retina, the trunks of which are so large in that place as to obstruct all vision.

To M. Pecquet's objection, founded on the opacity of the retina, M. Marriotte observes, that there must be a great difference betwixt the state of that substance in living and dead subjects; and as a farther proof of the transparency of the retina, and the power of the choroides beyond it to reflect light, he says, that if a lighted candle be held near to a person's eyes, and a dog, at the distance of eight or ten steps, be made to look at him, he would see a bright light in the dog's eyes, which he thought to proceed from the reflection of the light of the candle from the choroides of the dog, since the same appearance cannot be produced in the eyes of men, or other animals, whose choroides is black.

To M. Pecquet's remark concerning the blood vessels of the retina, M. Marriotte observes, that they are not large enough to prevent vision in every part of the base of the nerve, since the diameter of each of the two vessels occupy no more than $\frac{1}{8}$ part of it. Besides, if this were the cause of this want of vision, it would vanish gradually, and the space to which it is confined would not be so exactly terminated as it appears to be.

We must add, that M. Pecquet also observed, that notwithstanding the insensibility of the retina at the insertion of the optic nerve when the light is only moderate; yet that luminous objects, such as a bright candle placed at the distance of four or five paces, do not

(A) M. Musschenbroeck says, that in many animals, as the lion, camel, bear, ox, stag, sheep, dog, cat, and many birds, the choroides is not black, but blue, green, yellow, or some other colour. *Introductio*, Vol. II. p. 748.

not abſolutely diſappear, in the ſame circumſtances in which a white paper would; for that this ſtrong light may be perceived though the picture fall on the baſe of the nerve. " I cannot help ſuſpecting, however, (ſays Dr Prieſtley), that M. Pecquet did not make this obſervation with ſufficient care. A large candle makes no impreſſion on that part of my eye, though it is by no means able to bear a ſtrong light."

The common opinion was alſo favoured by the anatomical deſcription of ſeveral animals by the members of the French academy, and particularly their account of the ſea-calf and porcupine; in both of which the optic nerve is inſerted in the very axis of the eye, exactly oppoſite to the pupil, which was thought to leave no room to doubt, but that in theſe animals the retina is perfectly ſenſible to the impreſſion of light at the inſertion of the nerve. But this obſervation may deſerve to be reconſidered.

M. De la Hire took part with M. Pecquet, arguing in favour of the retina from the analogy of the ſenſes, in all of which the nerves are the proper ſeat of ſenſation. This philoſopher, however, ſuppoſed that the choroides receives the impreſſions of images, in order to tranſmit them to the retina.

M. Perrault alſo took the part of M. Pecquet againſt M. Marriotte, and in M. Perrault's works we have ſeveral letters that paſſed between theſe two gentlemen upon this ſubject.

This diſpute about the immediate inſtrument of viſion was revived upon the occaſion of an odd experiment of M. Mery, recorded in the memoirs of the French academy for 1704. He plunged a cat in water, and expoſing her eye to the ſtrong light of the ſun, obſerved that the pupil was not at all contracted by it; from which he concluded, that the contraction of the iris is not produced by the action of the light, but by ſome other circumſtance. For he contended that the eye receives more light in this ſituation than in the open air. At the ſame time he thought he obſerved that the retina of the cat's eye was tranſparent, and that he could ſee the opaque choroides beyond it; from which he concludes, that the choroides is the ſubſtance intended to receive the rays of light, and to be the chief inſtrument of viſion. But M. De la Hire replies to this argument of M. Mery, in a memoir for the year 1709, p. 119; in which he endeavours to ſhew that fewer rays enter the eye under water, and that in thoſe circumſtances it is not ſo liable to be affected by them. Beſides, it is obvious to be remarked, that the cat muſt be in great terror in this ſituation; and being an animal that has a very great voluntary power over the muſcles of the iris, and being now extremely attentive to every thing about her, ſhe might keep her eye open notwithſtanding the action of the light upon it, and though it might be very painful to her. We are informed, that when a cat is placed in a window through which the ſun is ſhining, and conſequently her iris nearly cloſed, if ſhe hear a ruſtling, like that which is made by a mouſe, on the outſide of the window, ſhe will immediately open her eyes to their greateſt extent, without in the leaſt turning her face from the light.

M. Le Cat took part with M. Marriotte in this controverſy, it being peculiarly agreeable to this general hypotheſis, *viz.* that the pia mater, of which the choroides is a production, and not the nerves themſelves, is the proper inſtrument of ſenſation. He thought that the change which takes place in the eyes of old people (the choroides growing leſs black with age) favoured his hypotheſis, as they do not ſee with that diſtinctneſs with which young perſons do. M. Le Cat ſuppoſed that the retina anſwers a purpoſe ſimilar to that of the ſcarf-ſkin, covering the papillæ pyramidales, which are the immediate organ of feeling, or that of the porous membrane which covers the glandulous papillæ of the tongue. The retina, he ſays, receives the impreſſion of light, moderates it, and prepares it for its proper organ, but is not itſelf ſenſible of it.

It muſt be obſerved, that M. Le Cat had diſcovered that the pia mater, after cloſely embracing and conſtringing the optic nerve at its entrance into the eye, divides into two branches, one of which cloſely lines the cornea, and at length is loſt in it, while the ſecond branch makes what is called the *choroides*, or *uvea*. He alſo ſhewed that the ſclerotica is an expanſion of the dura mater; and he ſent diſſections of the eye to the royal academy of ſciences in 1739, to prove theſe aſſertions, and ſeveral others which he had advanced in his *Traité des Sens*, that were contrary to the opinions of the celebrated Winſlow.

To theſe arguments in favour of the choroides, alleged by thoſe gentlemen among whom the ſubject was firſt diſcuſſed, Dr Prieſtley in his hiſtory adds the following that had eſcaped their notice, but which were ſuggeſted to him by his friend Mr Michell.

In order that viſion be diſtinct, the pencils of rays which iſſue from the ſeveral points of any object, muſt be collected either accurately, or at leaſt very nearly, to correſponding points in the eye, which can only be done upon ſome uniform ſurface. But the retina being of a conſiderable thickneſs, and the whole of it being uniformly nervous, and at leaſt nearly, if not perfectly, tranſparent, preſents no particular ſurface; ſo that, in whatever part of it the pencils be ſuppoſed to have their foci, the rays belonging to them will be ſeparated from one another, either before or after they arrive there, and conſequently viſion would be confuſed.

If we ſuppoſe the ſeat of viſion to be at the nearer ſurface of the retina, and the images of objects be formed by direct rays, a conſiderable degree of confuſion could not but ariſe from the light reflected by the choroides, in thoſe animals in which it is white, or coloured. On the other hand, it would be impoſſible that viſion ſhould be performed at this place by light reflected from the choroides, becauſe in many animals it is perfectly black, and reflects no light at all; and yet ſuch animals ſee even more diſtinctly than others. And we cannot but ſuppoſe that, in whatever manner viſion is effected, it is the ſame in the eyes of all animals.

If the ſeat of viſion be at the farther ſurface of the retina, and it be performed by direct rays, a white choroides could be of no uſe; and if it were by reflected rays, a black one could not anſwer the purpoſe.

It is likewiſe an argument in favour of the choroides being the organ of viſion, that it is a ſubſtance which receives a more diſtinct impreſſion from the rays of light than any other membrane in any part of the animal ſyſtem, excepting (and perhaps not excepting) that white cuticle which lies under the ſcales of fiſhes; whereas

whereas the retina is a ſubſtance on which the light makes an exceedingly faint impreſſion, and perhaps no impreſſion at all; ſince light, in paſſing out of one tranſparent medium into another immediately contiguous to it, ſuffers no refraction or reflection, nor are any of the rays abſorbed, unleſs there is ſome difference in the refracting power of the two media, which probably is not the caſe between the retina and the vitreous humour, which is in contact with it. And wherever the light is not affected by the medium it falls upon, we can hardly ſuppoſe the medium to receive any impreſſion from the light, the action being probably always mutual and reciprocal.

Beſides, the retina is ſo ſituated, as to be expoſed to many rays beſides thoſe which terminate in it, and which, therefore, cannot be ſubſervient to viſion, if it be performed there. Now this is not the caſe with the choroides, which is in no ſhape tranſparent, and has no reflecting ſubſtance beyond it.

It is, moreover, peculiarly favourable to the hypotheſis of the ſeat of viſion being in the choroides, that we can then ſee a ſufficient reaſon for the diverſity of its colour in different animals, according as they are circumſtanced with reſpect to viſion. In all terreſtrial animals, which have occaſion to make uſe of their eyes by night, the choroides is either of a bright white, or of ſome very vivid colour, which reflects the light very ſtrongly. On this account viſion may be performed with leſs light, but it cannot be with great diſtinctneſs, the reflection of the rays doubling their effect; ſince it muſt extend over ſome ſpace, all reflection being made at a diſtance from the reflecting body. Beſides, the choroides in brutes is not in general perfectly white, but a little inclined to blue; and is therefore, probably, better adapted to ſee by the fainter coloured light, which chiefly prevails in the night; and, we would add, is on the ſame account more liable to be ſtrongly impreſſed by the colours to which they are chiefly expoſed.

On the other hand, the choroides of birds in general, eſpecially eagles, hawks, and other birds of prey, is black; by which means they are able to ſee with the greateſt diſtinctneſs, but only in bright day-light. The owl, however, ſeeking her food by night, has the choroides white, like that of a cat. Laſtly, in the eyes of man, which are adapted to various uſes, the choroides is neither ſo black as that of birds, nor ſo white as that of thoſe animals who make the greateſt uſe of their eyes in the night.

As to a third hypotheſis, which is in effect that of M. De la Hire, which makes both the retina and the choroides equally neceſſary to viſion, and ſuppoſe it be performed by the impreſſion of light on the choroides communicated to the retina; Mr Michell obſerves, that the perceptions can hardly be ſuppoſed to be ſo acute, when the nerves, which are the chief inſtruments of ſenſation, do not receive the impreſſions immediately, but only after they have been communicated to another ſubſtance. Beſides, it muſt be more natural to ſuppoſe, that, when the principal impreſſion is made upon the choroides, it is communicated to the brain by its own proper nerves, which are abundantly ſufficient for the purpoſe.

120 Dimenſions of the ſpot in the eye where there is no viſion.

The dimenſions and preciſe form of the ſpot in the eye in which there is no viſion, were more accurately calculated by Daniel Bernoulli, in the following manner. He placed a piece of money O, fig. 1, upon the floor; and then ſhutting one of his eyes, and making a pendulum to ſwing, ſo that the extremity of it might be nearly in the line AO, he obſerved at what place C it began to be inviſible, and where it again emerged into view at A. Raiſing the pendulum higher and lower, he found other points, as H, N, P, G, B, at which it began to be inviſible; and others, as M, L, E, A, at which it began to be viſible again; and drawing a curve through them, he found that it was elliptical; and, with reſpect to his own eye, the dimenſions of it were as follows, OC was 23, AC 10, BD 3, DH 13, and EG 14; ſo that the centre being at F, the greater axis was to the leſs as 8 to 7. Plate CCXI.

From theſe *data*, the plane on which the figure was drawn being obliquely ſituated with reſpect to the eye, he found, that the place in the eye that correſponded to it was a circle, the diameter of which was a ſeventh part of the diameter of the eye, the centre of it being 27 parts of the diameter from the point oppoſite to the pupil, a little above the middle. He concludes with obſerving, that, in order that this ſpace in which there is no viſion, may be as ſmall as poſſible, it was neceſſary that the nerve ſhould enter the eye perpendicularly, and that both this end, and alſo its entering the eye at a diſtance from its axis, are gained by the particular manner in which the two optic nerves unite and become ſeparate again, by croſſing one another.

In favour of one of the obſervations of Mr Michell, concerning the uſe of the choroides in viſion, Dr Prieſtley obſerves, that Aquapendente mentions the caſe of a perſon at Piſa, who could ſee very well in the night, but very little or none at all in the day-time. This is alſo ſaid to be the caſe with thoſe white people among the blacks of Africa, and the inhabitants of the iſthmus of America, who, from this circumſtance, are called *moon-eyed*. Our author thinks it probable that their choroides is not of a dark colour, as it is in others of the human ſpecies; but white, or light coloured, as in thoſe animals which have moſt occaſion for their eyes in the night.

The following conſiderations in favour of the retina being the proper ſeat of viſion are worthy of remark.

Dr Porterfield obſerves, that the reaſon why there is no viſion at the enterance of the optic nerve into the eye, may be, that it wants that ſoftneſs and delicacy, which it has when it is expanded upon the choroides; and that, in thoſe animals in which that nerve is inſerted in the axis of the eye, it is obſerved to be equally delicate, and therefore probably equally ſenſible, in that place as in any other part of the retina. In general, the nerves, when conſtringed by their coats, have but little ſenſibility, in compariſon of what they are endued with when they are diveſted of them, and unfolded in a ſoft and pulpy ſubſtance.

Haller obſerves, that the choroides cannot be the univerſal inſtrument of viſion, becauſe that ſometimes in men and birds, but eſpecially in fiſhes, it is covered internally with a black mucus, through which the rays cannot penetrate. This writer ſpeaks of a fibrous membrane in the retina diſtinct from its pulpy ſubſtance. On theſe fibres, he conjectures, that the images of objects are painted.

M. De la Hire's argument in favour of the retina, from

Of Refraction.

from the analogy of the senses, is much strengthened by considering that the retina is a large nervous apparatus, immediately exposed to the impression of light; whereas the choroides receives but a slender supply of nerves, in common with the sclerotica, the conjunctiva, and the eyelids, and that its nerves are much less exposed to the light than the naked fibres of the optic nerve. Indeed, from anatomical considerations, one might imagine that any other part of the body was as sensible of the impression of light, as the choroides.

That the optic nerve is of principal use in vision is farther probable from several phenomena attending some of the diseases in which the sight is affected. When an amaurosis has affected one eye only, the optic nerve of that eye has been found manifestly altered from its sound state. Dr Priestley was present when Mr Hey examined the brain of a young girl, who had been blind of one eye, and saw that the optic nerve belonging to it was considerably smaller than the other; and he informed him, that, upon cutting into it, he found it to be much harder, and cineritious. Morgagni, indeed, mentions two cases, in one of which he found the optic nerves smaller than usual, and of a cineritious colour, when, upon inquiry, he was informed that the person had not been blind, though there might have been some defect in the sight of one of the eyes. In the other case, only one of the optic nerves was affected in that manner, and the eye itself was in other respects very perfect. Here, also, he was expressly told that the person was not blind of that eye: but it appears that he himself had not been acquainted with the persons whom he dissected; and there have been many cases of persons being blind of one eye, without knowing it themselves, for a considerable time.

Moreover, as the optic nerve is solely spent in forming the retina, so no function of the eye, not immediately subservient to vision, is affected by an amaurosis. On the contrary, those nerves which go to the choroides are found to retain, in this disease, their natural influence. The iris will contract in a recent gutta serena of one eye, if the other remains sound, and is suddenly exposed to a strong light. The sclerotis, conjunctiva, and eyelids, which receive their nerves from the same branches as the choroides retain their sensibility in this disorder.

The manner in which persons recover from an amaurosis, favours the supposition of the seat of vision being in the retina; since those parts which are the most distant from the insertion of the nerve recover their sensibility the soonest, being, in those places, the most pulpy and softest; whereas there is no reason to think that there is any difference in this respect in the different parts of the choroides. Mr Hey has been repeatedly informed, by persons labouring under an imperfect amaurosis, or gutta serena, that they could not, when looking at any object with one eye, see it so distinctly when it was placed directly opposite to the pupil, as when it was situated somewhat obliquely. And those persons whom he had known to recover from a perfect amaurosis, first discovered the objects whose images fell upon that part of the retina which is at the greatest distance from the optic nerve.

We shall conclude these remarks with observing, that, if the retina be as transparent as it is generally represented to be, so that the termination of the pencils must necessarily be either upon the choroides, or some other opaque substance interposed between it and the retina, the action and reaction occasioned by the rays of light being at the common surface of this body and the retina, both these mediums (supposing them to be equally sensible to the impression of light) may be equally affected; but the retina, being naturally much more sensible to this kind of impression, may be the only instrument by which the sensation is conveyed to the brain, though the choroides, or the black substance with which it is sometimes lined, may also be absolutely necessary for the purpose of vision. Indeed, when the reflection of the light is made at the common boundary of any two mediums, it is with no propriety that this effect is ascribed to one of them rather than the other; and the strongest reflections are often made back into the densest mediums, when they have been contiguous to the rarest, or even to a vacuum. This is not far from the hypothesis of M. De la Hire, and will completely account for the entire defect of vision at the insertion of the optic narve.

121 Of bright and obscure vision.

Vision is distinguished into *bright* and *obscure*, *distinct* and *confused*.—It is said to be bright, when a sufficient number of rays enter the pupil at the same time; obscure, when too few. It is distinct when each pencil of rays is collected into a focus exactly upon the retina; *confused*, when they meet before they come at it, or when they would pass it before they meet; for, in either of these last cases, the rays flowing from different parts of the object, will fall upon the same part of the retina, which must necessarily render the image confused and indistinct.—Now, that objects may appear with a due brightness, whether more or fewer rays proceed from them, we have a power of contracting or dilating the pupil by means of the muscular fibres of the iris, in order to take in more or fewer rays as occasion requires. But this power has its limits. In some animals it is much greater than in others; particularly in such as are obliged to seek their food by night, as well as by day, as in cats, &c.

122 Of distinct vision at different distances.

That the rays may be collected into points exactly upon the retina, that is, that objects may appear distinct, whether they be nearer or farther off, *i. e.* whether the rays proceeding from them diverge more or less, we have a power of contracting or relaxing the ligamenta ciliaria, and thereby altering the form of the crystalline humour, and with it the focal distance of the rays. Thus, when the object we view is far off, and the rays fall upon the pupil with a very small degree of divergency, we contract the *ligamenta ciliaria*, which, being concave towards the vitreous humour, do thereby compress it more than otherwise they would do: by this means it is made to press harder upon the backside of the crystalline humour, which is thereby rendered flatter; and thus the rays proceed farther before they meet in a focus, than otherwise they would have done. Add to this, that we dilate the pupils of our eyes (unless in cases where the light is so strong that it offends the eye), and thereby admit rays into them that are more diverging than those which would otherwise enter. And, when the rays come from an object that is very near, and there-

fore diverge too much to be collected into their reſpective foci upon the retina; by relaxing the *ligamenta ciliaria*, we give the cryſtalline a more convex form, by which means the rays are made to ſuffer a proportionably greater degree of refraction in paſſing through it. Some philoſophers are of opinion that we do this by a power of altering the form of the eye; and others, by removing the cryſtalline forwards or backwards as occaſion requires: but neither of theſe opinions is probable; for the coats of the eye are too hard, in ſome animals, for the firſt; and, as to moving the cryſtalline out of its place, the cavities of the eye ſeem to be too well filled with the other humours to admit of ſuch removal.

Beſides this, in the caſe above-mentioned, by contracting the pupils of our eyes, we exclude the more diverging rays, and admit only ſuch as are more eaſily refracted into their reſpective foci (A). But viſion is not diſtinct at all diſtances, for our power of contracting and relaxing the ligamenta ciliaria is alſo circumſcribed within certain limits.

123 Of ſhort-ſighted and long-ſighted people.

In thoſe eyes where the tunica cornea is very protuberant and convex, the rays of light ſuffer a very conſiderable refraction at their entrance into the aqueous humour, and are therefore collected into a focus before they fall upon the retina, unleſs the object be placed very near, ſo that the rays which enter the eye may have a conſiderable degree of divergency. People that have ſuch eyes are ſaid to be *purblind*. Now, the nearer an object is to the eye, the greater is the image of it therein, as explained above: theſe people therefore can ſee much ſmaller objects than others, as ſeeing much nearer ones with the ſame diſtinctneſs; and their ſight continues good longer than that of other people, becauſe the tunica cornea of their eyes, as they grow old, becomes plainer, for want of that redundancy of humours with which they were filled before. On the contrary, old men, having the cornea of their eyes too flat for want of a ſufficient quantity of the aqueous humour to fill them out, if the rays diverge too much before they enter the eye, they cannot be brought to a focus before they reach the retina; on which account thoſe people cannot ſee diſtinctly, unleſs the object be ſituated at a greater diſtance from the eye, than is required for thoſe whoſe eyes are of a due form. The latter require the aſſiſtance of convex glaſſes, to make them ſee objects diſtinctly; the former of concave ones. For if either the cornea *abc* (fig. 5.), or cryſtalline humour *e*, or both of them, be too flat, as in the eye A, their focus will not be on the retina as at A, where it ought to be, in order to render viſion diſtinct; but beyond the eye, as at *f*. This is remedied by placing a convex glaſs *gh* before the eye, which makes the rays converge ſooner, and imprints the image duely on the retina at *d*. Again, if either the cornea, or cryſtalline humour, or both of them, be too convex, as in the eye B, the rays that enter it from the object C will be converged to a focus in the vitreous humour, as at *f*; and by diverging from thence to the retina, will form a very confuſed image thereon; and ſo, of courſe, the obſerver will have as confuſed a view of the object as if his eye had been too flat. This inconvenience is remedied by placing a concave glaſs *gh* before the eye; which glaſs, by cauſing the rays to diverge between it and the eye, lengthens the focal diſtance ſo, that if the glaſs be properly choſen, the rays will unite at the retina, and form a diſtinct image of the object upon it.

Plate CCX.

124 Of the leaſt angle of viſion.

Such eyes as are of a due convexity, cannot ſee any object diſtinctly at leſs diſtance than ſix inches; and there are numberleſs objects too ſmall to be ſeen at that diſtance, becauſe they cannot appear under any ſenſible angle.—Concerning the leaſt angle under which any object is viſible, there was a debate between Dr Hooke and Hevelius. The former aſſerted, that no object could well be ſeen if it ſubtended an angle leſs than one minute; and, if the object be round, as a black circular ſpot upon a white ground, or a white circle upon a black ground, it follows, from an experiment made by Dr Smith, that this is near the truth; and from thence he calculates, that the diameter of the picture of ſuch leaſt viſible point upon the retina is the 8000th part of an inch; which he therefore calls a *ſenſible point of the retina*. On the other hand, Mr Courtivron concluded from his experiments, that the ſmalleſt angle of viſion was 40 ſeconds. According to Dr Jurin, there are caſes in which a much ſmaller angle than one minute can be diſcerned by the eye; and in order to throw light upon the ſubject, he obſerves, that, in order to our perceiving the impreſſion made by any object upon our ſenſes, it muſt either be of a certain degree of force, or of a certain degree of magnitude. For this reaſon a ſtar, which appears only as a lucid point through a teleſcope, ſubtending not ſo much as an angle of one ſecond, is viſible to the eye; though a white or black ſpot, of 25 or 30 ſeconds, is not to be perceived. Alſo a line of the ſame breadth with the circular ſpot will be viſible, at ſuch a diſtance as the ſpot is not to be perceived at; becauſe the quantity of impreſſion from the line is much greater than from the ſpot; and a longer line is viſible at a greater diſtance than a ſhorter one of the ſame breadth. He found by experience, that a ſilver wire could be ſeen when it ſubtended an angle of three ſeconds and an half; and that a ſilk thread could be ſeen when it ſubtended an angle of two ſeconds and a half.

125 Lines can be ſeen under ſmaller angles than ſpots, and why.

This greater viſibility of a line than of a ſpot, ſeems to ariſe only from the greater quantity of the impreſſion; but without the limits of perfect viſion, our author obſerves, that another cauſe concurs, whereby the difference of viſibility between the ſpot and the line is rendered much more conſiderable. For the impreſſion upon the retina made by the line is then not only much greater, but alſo much ſtronger than that of the ſpot; becauſe the faint image, or penumbra, of any one point of the line, when the whole is placed beyond the limits of diſtinct viſion, will fall within the faint image of the next point, and thereby much increaſe the light that comes from it.

In ſome caſes our author found the cauſe of indiſtinct viſion to be the unſteadineſs of the eye; as our being able to ſee a ſingle black line upon a white ground, or a ſingle white line upon a black ground, and

(A) Accordingly it is obſerved, that if we make a ſmall hole with the point of a needle through a piece of paper, and apply that hole cloſe to the eye, making uſe of it, as it were, inſtead of a pupil, we ſhall be able to ſee an object diſtinctly through it, though the object be placed within half an inch of the eye.

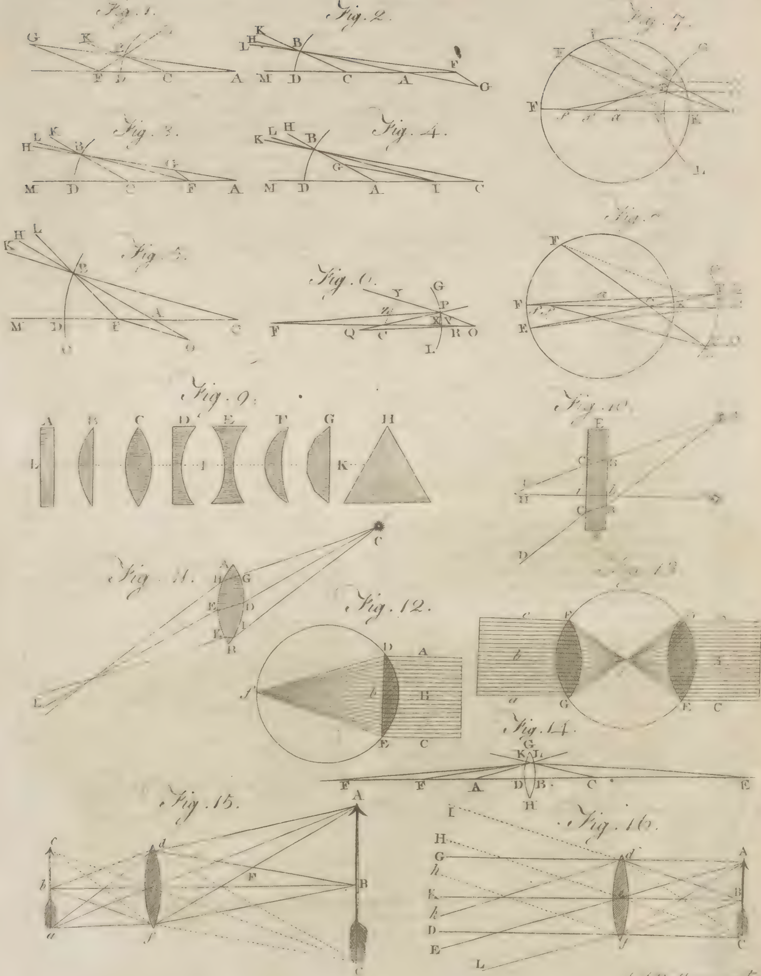


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 9.
Fig. 11.
Fig. 12.
Fig. 14.
Fig. 15.
Fig. 16.

Of Refraction.

and not a white line between two black ones on a white ground. In viewing either of the former objects, if the eye be imperceptibly moved, all the effect will be, that the object will be painted upon a different part of the retina; but, wherever it is painted, there will be but one picture, single and uncompounded with any other. But in viewing the other, if the eye fluctuate ever so little, the image of one or other of the black lines will be shifted to that part of the retina which was before possessed by the white line; and this must occasion such a dazzle in the eye, that the white line cannot be distinctly perceived, and distinguished from the black lines; which, by a continual fluctuation, will alternately occupy the space of the white line, whence must arise an appearance of one broad dark line, without any manifest separation.

By trying this experiment with two pins of known diameters, set in a window against the sky light, with a space between them equal in breadth to one of the pins, he found that the distance between the pins could hardly be distinguished when it subtended an angle of less than 40 seconds, though one of the pins alone could be distinguished when it subtended a much less angle. But though a space between two pins cannot be distinguished by the eye when it subtends an angle less than 40 seconds, it would be a mistake to think that the eye must necessarily commit an error of 40 seconds in estimating the distance between two pins when they are much farther from one another. For if the space between them subtend an angle of one minute, and each of the pins subtend an angle of four seconds, which is greater than the least angle the eye can distinguish, it is manifest that the eye may judge of the place of each pin within two seconds at the most; and consequently the error committed in taking the angle between them cannot at the most exceed four seconds, provided the instrument be sufficiently exact. And yet, says he, upon the like mistake was founded the principal objection of Dr Hooke against the accuracy of the celestial observations of Hevelius.

A black spot upon a white ground, or a white spot upon a black ground, he says, can hardly be perceived by the generality of eyes when it subtends a less angle than one minute. And if two black spots be made upon white paper, with a space between them equal in breadth to one of their diameters, that space is not to be distinguished, even within the limits of perfect vision, under so small an angle as a single spot of the same size can be distinguished. To see the two spots distinctly, therefore, the breadth of the space between them must subtend an angle of more than a minute. It would be very difficult, he says, to make this experiment accurately, within the limits of perfect vision; because the objects must be extremely small: but by a rude trial, made with square bits of white paper, placed upon a black ground, he judged, that the least angle under which the interval of two objects could be perceived, was at least a fourth part greater than the least angle under which a single object can be perceived. So that an eye which cannot perceive a single object under a smaller angle than one minute, will not perceive the interval between two such objects under a less angle than 75 seconds.

Without the limits of perfect vision, the distance at which a single object ceases to be perceivable will be much greater in proportion than the distance at which a space of equal breadth between two such objects ceases to be perceivable. For, without these limits, the image of each of the objects will be attended with a penumbra, and the penumbra of the two near objects will take up part of the space between them, and thereby render it less perceivable; but the penumbra will add to the breadth of the single object, and will thereby make it more perceivable, unless its image be very faint. Upon the same principles he likewise accounts for the radiation of the stars, whereby the light seems to project from them different ways at the same time.

Mr Mayer made many experiments in order to ascertain the smallest angle of vision in a variety of respects. He began with observing at what distance a black spot was visible on white paper; and found, that when it could barely be distinguished, it subtended an angle of about 34 seconds. When black lines were disposed with intervals broader than themselves, they were distinguished at a greater distance than they could be when the objects and the intervals were of an equal breadth. In all these cases it made no difference whether the objects were placed in the shade, or in the strong light of the sun; but when the degrees of light were small, their differences had a considerable effect, though by no means in proportion to the differences of the light. For if an object was illuminated to such a degree as to be just visible at the distance of nine feet, it would be visible at the distance of four feet, tho' the light was diminished above 160 times. It appeared in the course of these experiments, that common day-light is, at a medium, equal to that of 25 candles placed at the distance of one foot from the object.

126 Of single vision with two eyes.

As an image of every visible object is painted on the retina of each of our eyes, it thence becomes a natural question, Why we do not see every thing double? It was the opinion of Sir Isaac Newton and others, that objects appear single because the two optic nerves unite before they reach the brain. But Dr Porterfield shews, from the observation of several anatomists, that the optic nerves do not mix, or confound their substance, being only united by a close cohesion; and objects have appeared single where the optic nerves were found to be disjoined.

Dr Briggs supposed that single vision was owing to the equal tension of the corresponding parts of the optic nerves, whereby they vibrated, in a synchronous manner. But, besides several improbable circumstances in this account, Dr Porterfield shews that facts do by no means favour it.

To account for this phenomenon, this ingenious writer supposes, that by an original law in our natures, we imagine objects to be situated somewhere in a right line drawn from the picture of it upon the retina, through the centre of the pupil. Consequently, the same object appearing to both eyes to be in the same place, the mind cannot distinguish it into two. In answer to an objection to this hypothesis, from objects appearing double when one eye is distorted, he says the mind mistakes the position of the eye, imagining that it had moved in a manner corresponding to the other, in which case the conclusion would have

have been just. In this he seems to have recourse to the power of habit, tho' in words he disclaims that hypothesis.

This principle, however, has generally been thought to be sufficient to account for this appearance. Originally, every object making two pictures, one in each eye, is imagined to be double; but, by degrees, we find, that when two corresponding parts of the retina are impressed, the object is but one; but if those corresponding parts be changed, by the distortion of one of the eyes, the object must again appear double as at the first. This seems to be verified by Mr Cheselden; who informs us, that a gentleman, who from a blow on his head had one eye distorted, found every object to appear double; but by degrees the most familiar ones came to appear single again, and in time all objects did so, without any amendment of the distortion. A case similar to this is mentioned by Dr Smith.

On the other hand, Dr Reid is of opinion, that the correspondence of the centres of the two eyes, on which single vision depends, does not arise from custom, but from some natural constitution of the eye and of the mind. He makes several just objections to the case of Mr Foster, recited by Dr Smith and others; and thinks that the case of the young man couched by Cheselden, who saw singly with both eyes immediately upon receiving his sight, is nearly decisive in proof of his supposition. He also found that three young gentlemen, whom he endeavoured to cure of squinting, saw objects singly, as soon as ever they were brought to direct the centres of both their eyes to the same object, though they had never been used to do so from their infancy; and he observes, that there are cases, in which, notwithstanding the fullest conviction of an object being single, no practice of looking at it will ever make it appear so, as when it is seen thro' a multiplying glass.

We are indebted to Dr Jurin for the following curious experiments to determine whether an object seen by both eyes appears brighter than when seen with one only.

He laid a slip of clean white paper directly before him on a table, and applying the side of a book close to his right temple, so as that the book was advanced considerably more forward than his face, he held it in such a manner, as to hide from his right eye that half of the paper which lay to his left hand, while the left half of the paper was seen by both eyes, without any impediment.

Then looking at the paper with both eyes, he observed it to be divided, from the top to the bottom, by a dark line, and the part which was seen with one eye only was manifestly darker than that which was seen with both eyes; and, applying the book to his left temple, he found, by the result of the experiment, that both his eyes were of equal goodness.

He then endeavoured to find to what degree this excess of brightness amounted; and comparing it with the appearance of an object illuminated partly by one candle and parly by two, he was surprised to find that an object seen with two eyes is by no means twice as luminous as when it is seen with one only; and after a number of trials, by which he made the proportion less and less continually, he found, that when one paper was illuminated by a candle placed at the distance of three feet, and another paper by the same candle at the same distance, and by another candle at the distance of 11 feet, the former seen by both eyes, and the latter with one eye only, appeared to be of equal whiteness; so that an object seen with both eyes appears brighter than when it is seen with one only by about a 13th part. But he acknowledges, that is difficult to make this experiment exactly.

He then proceeded to inquire, whether an object seen with both eyes appears any thing larger than when seen with one only; but he concluded that it did not, except on account of some particular circumstances, as in the case of the binocular telescope, and the concave speculum.

M. Du Tour maintains, that the mind attends to no more than the image made in one eye at a time; and produces several curious experiments in favour of this hypothesis, which had also been maintained by Kepler and almost all the first opticians. But, as M. Buffon observes, it is a sufficient answer to this hypothesis, how ingeniously soever it may be supported, that we see more distinctly with two eyes than one; and that when a round object is near us we plainly see more of the surface in one case than in the other. There are, also, other facts, which clearly prove the contrary of what is maintained by M. Du Tour.

With respect to single vision with two eyes, Dr Hartley observes, that it deserves particular attention, that the optic nerves of men, and such other animals as look the same way with both eyes, unite in the *sella turcica* in a ganglion, or little brain, as one may call it, peculiar to themselves; and that the associations between synchronous impressions on the two retinas must be made sooner and cemented stronger on this account; also that they ought to have a much greater power over one another's images, than in any other part of the body. And thus an impression made on the right eye alone, by a single object, may propagate itself into the left, and there raise up an image almost equal in vividness to itself; and consequently when we see with one eye only, we may, however, have pictures in both eyes.

A curious deception in vision, arising from the use of both eyes, was observed and accounted for by Dr Smith. It is a common observation, he says, that objects seen with both eyes appear more vivid and stronger than they do to a single eye; especially when both of them are equally good. A person not short-sighted may soon be convinced of this fact, by looking attentively at objects that are pretty remote, first with one eye, and then with both. This observation gave occasion to the construction of the binocular telescope, in the use of which the phenomenon is still more striking.

Besides this, our author observes, that there is another phenomenon observable with this instrument, which is very remarkable. In the foci of the two telescopes there are two equal rings, as usual, which terminate the pictures of the objects there formed, and consequently the visible area of the objects themselves. These equal rings, by reason of the equal eye-glasses, appear equal, and equally distant when seen separately by each eye; but when they are seen with both eyes, they appear much larger, and more distant also; and the

Of Refraction.

the objects seen through them do also appear much larger, though circumscribed by their united rings, in the same places as when they were seen separately.

He observes, that the phenomenon of the enlarged circle of the visible area in the binocular telescope, may be seen very plainly in looking at distant objects through a pair of spectacles, removed from the eyes about four or five inches, and held steady at that distance. The two innermost of the four apparent rings, which hold the glasses, will then appear united in one larger and more distant ring than the two outermost, which will hardly be visible unless the spectacles be farther removed.

A curious circumstance relating to the effect of one eye upon the other, was noticed by M. Æpinus, who observed, that, when he was looking through a hole made in a plate of metal, about the 10th part of a line in diameter, with his left eye, both the hole itself appeared larger, and also the field of view seen thro' it was more extended, whenever he shut his right eye; and both these effects were more remarkable when that eye was covered with his hand. He found considerable difficulty in measuring this augmentation of the apparent diameter of the hole, and of the field of view; but at length he found, that, when the hole was half an inch, and the tablet which he viewed through it was three feet from his eye, if the diameter of the field when both his eyes were open was 1, it became $1\frac{1}{2}$ when the other eye was shut, and nearly 2 when his hand was laid upon it.

Upon examining this phenomenon, it presently appeared to depend upon the enlargement of the pupil of one eye when the other is closed, the physical or anatomical cause of which he did not pretend to assign; but he observes, that it is wisely appointed by divine Providence, in order that when one eye fails, the field of view in the other may be extended. That this effect should be more sensible when the eye is covered with the hand, is owing, he observes, to the eye-lids not being impervious to the light. But the enlargement of the pupil does not enlarge the field of view, except in looking through a hole, as in this particular case; and therefore persons who are blind of one eye can derive no advantage from this circumstance. Before we applaud the wisdom of Providence in any part of the constitution of nature, we should be very sure that we do not mistake concerning the effects of that constitution.

A great deal has been written by Gassendi, Le Clerc, Muschenbroek, and Du Tour, concerning the place to which we refer an object viewed by one or both eyes. But the subject is not of much consequence. Any person may presently satisfy himself with respect to every thing belonging to this circumstance, either by experiment, holding his finger before his eyes, and looking at it and an object beyond it; or by figures, in which lines representing the optic axes may be made to cross one another at different distances from the eye.

§ 4. *Of the Appearance of Objects seen through Media of different Forms.*

For the more easy apprehension of what relates to this subject, we shall premise the five following particulars, which either have been already mentioned, or follow from what has been before laid down.

Of Refraction.

1. That as each point of an object, when viewed by the naked eye, appears in its proper place; and as that place is always to be found in the line in which the axis of a pencil of rays flowing from it enters the eye; we from hence acquire an habit of judging the point to be situated in that line: and, because the mind is unacquainted with what refractions the rays suffer before they enter the eye, therefore, in cases where they are diverted from their natural course, by passing through any medium, it judges the point to be in that line produced back in which the axis of a pencil of rays flowing from it is situated the instant they enter the eye, and not in that it was in before refraction. We shall therefore, in what follows, suppose the apparent place of an object, when seen thro' a refracting medium, to be somewhere in that line produced back in which the axis of a pencil of rays flowing from it proceeds after they have passed through the medium.

2. That we are able to judge, though imperfectly, of the distance of an object by the degree of divergency, wherein the rays flowing from the same point of the object enter the pupil of the eye, in cases where that divergency is considerable; but because in what follows it will be necessary to suppose an object, when seen through a medium whereby its apparent distance is altered, to appear in some determinate situation, in those cases where the divergency of the rays at their entrance into the eye is considerable, we will suppose the object to appear where those lines which they describe in entering, if produced back, would cross each other: though it must not be asserted, that this is the precise distance; because the brightness, distinctness, and apparent magnitude of the object, on which its apparent distance in some measure depends, will also suffer an alteration by the refraction of the rays in passing through that medium.

3. That we estimate the magnitude of an object by that of the optic angle.

4. That vision is the brighter, the greater the number of rays is which enter the pupil. And,

5. That, in some cases, the apparent brightness, distinctness, and magnitude of an object, are the only means whereby our judgment is determined in estimating the distance of it.

Prop. I. An object placed within a medium terminated by a plane surface on that side which is next the eye, if the medium be denser than that in which the eye is (as we shall always suppose it to be, unless where the contrary is expressed), appears nearer to the surface of the medium than it is.

Thus, if A be a point of an object placed within the medium BDCE (fig. 2.), and A b A c be two rays proceeding from thence, these rays passing out of a denser into a rarer medium, will be refracted from their respective perpendiculars $b\,d$, $c\,e$, and will enter the eye at H, suppose in the directions bf, cg, let then these lines be produced back till they meet in F; this will be the apparent place of the point A: and because the refracted rays bf, cg will diverge more than the incident ones A b, A c, it will be nearer to the points b and c, than the point A; and as the same is true of each point in the object, the whole

Plate CCXI.

whole will appear to an eye at H, nearer to the surface BC than it is.

From hence it is, that when one end of a straight stick is put under water, and the stick is held in an oblique position, it appears bent at the surface of the water; viz. because each point that is under water appears nearer the surface, and consequently higher than it is.

From hence likewise it is, that an object at the bottom of a vessel may be seen when the vessel is filled with water, though it be so placed with respect to the eye, that it cannot be seen when the vessel is empty. To explain this, let ABCD (fig. 3.) represent a vessel, and let E be an object lying at the bottom of it. This object, when the vessel is empty, will not be seen by an eye at F, because HB, the upper part of the vessel, will obstruct the ray EH; but when it is filled with water to the height GH, the ray EK being refracted at the surface of the water into the line KF, the eye at F shall see the object by means of that.

Plate CCXI.

In like manner, an object situated in the horizon appears above its true place, upon account of the refraction of the rays which proceed from it in their passage through the atmosphere of the earth. For, first, if the object be situated beyond the limits of the atmosphere, its rays in entering it will be refracted towards the perpendicular; that is, towards a line drawn from the point where they enter, to the centre of the earth, which is the centre of the atmosphere: and as they pass on, they will be continually refracted the same way, because they are all along entering a denser part, the centre of whose convexity is still the same point; upon which account the line they describe will be a curve bending downwards: and therefore none of the rays that come from that object can enter an eye upon the surface of the earth, except what enter the atmosphere higher than they need to do if they could come in a right line from the object: consequently the object must appear above its proper place. Secondly, if the object be placed within the atmosphere, the case is still the same; for the rays which flow from it must continually enter a denser medium whose centre is below the eye; and therefore being refracted towards the centre, that is, downwards as before, those which enter the eye must necessarily proceed as from some point above the object; wherefore the object will appear above its proper place.

From hence it is, that the sun, moon, and stars, appear above the horizon, when they are just below it; and higher than they ought to do, when they are above it: Likewise distant hills, trees, &c. seem to be higher than they are.

Further, the lower these objects are in the horizon, the greater is the obliquity with which the rays which flow from them enter the atmosphere, or pass from the rarer into the denser parts of it; and therefore they appear to be the more elevated by refraction: upon which account the lower parts of them are apparently more elevated than the other. This makes their upper and under parts seem nearer than they are; as is evident from the sun and moon, which appear of an oval form when they are in the horizon, their horizontal diameters appearing of the same length they would do if the rays suffered no refraction, while their vertical ones are shortened thereby.

Prop. II. An object seen through a medium terminated by plane and parallel surfaces, appears nearer, brighter, and larger, than with the naked eye.

For instance, let AB (fig. 4.) be the object, CDEF the medium, and GH the pupil of an eye, which is here drawn large to prevent confusion in the figure. And, 1st, let RK, RL, be two rays proceeding from the point R, and entering the denser medium at K and L; these rays will here by refraction be made to diverge less, and to proceed afterwards, suppose in the lines K*a*, L*b*; at *a* and *b*, where they pass out of the denser medium, they will be as much refracted the contrary way, proceeding in the lines *ac*, *bd*, parallel to their first directions. Produce these lines back till they meet in *e*: this will be the apparent place of the point R; and it is evident from the figure, that it must be nearer the eye than that point; and because the same is true of all other pencils flowing from the object AB, the whole will be seen in the situation *fg*, nearer to the eye than the line AB. 2d, As the rays RK, RL, would not have entered the eye, but have passed by it in the directions K*r*, L*t*, had they not been refracted in passing through the medium, the object appears brighter. 3d, The rays A*h*, B*i*, will be refracted at *h* and *i* into the less converging lines *hk*, *il*, and at the other surface into *k*M, *l*M, parallel to A*h* and B*i* produced; so that the extremities of the object will appear in the lines M*k*, M*l* produced, viz. in *f* and *g*, and under as large an angle *f*M*g*, as the angle A*q*B under which an eye at *q* would have seen it had there been no medium interposed to refract the rays; and therefore it appears larger to the eye at GH, being seen through the interposed medium, than otherwise it would have done. But it is here to be observed, that the nearer the point *e* appears to the eye on account of the refraction of the rays RK, RL, the shorter is the image *fg*, because it is terminated by the lines M*f* and M*g*, upon which account the object is made to appear less; and therefore the apparent magnitude of an object is not much augmented by being seen through a medium of this form.

Farther, it is apparent from the figure, that the effect of a medium of this form depends wholly upon its thickness; for the distance between the lines R*r* and *ec*, and consequently the distance between the points *e* and R, depends upon the length of the line K*a*: Again, the distance between the lines AM and *f*M, depends on the length of the line *hk*; but both K*a* and *kh* depend on the distance between the surfaces CE and DF, and therefore the effect of this medium depends upon its thickness.

Prop. III. An object seen through a convex lens, appears larger, brighter, and more distant, than with the naked eye.

To illustrate this, let AB (fig. 5.) be the object, CD the lens, and EF the eye. 1. From A and B, the extremities of the object, draw the lines AY*r*, BX*r*, crossing each other in the pupil of the eye; the angle A*r*B comprehended between these lines, is the angle under which the object would be seen with the naked eye. But by the interposition of a lens of this form, whose property it is to render converging rays more so, the

Of Refraction.

Plate CCXI. fig. 5.

the rays AY and BX will be made to crofs each other before they reach the pupil. There the eye at E will not perceive the extremities of the object by means of thefe rays (for they will pafs it without entering), but by fome others which muft fall without the points Y and X, or between them; but if they fall between them, they will be made to concur fooner than they themfelves would have done; and therefore, if the extremities of the object could not be feen by them, it will much lefs be feen by thefe. It remains therefore, that the rays which will enter the eye from the points A and B after refraction, muft fall upon the lens without the points Y and X; let then the rays AO and BP be fuch. Thefe after refraction entering the eye at r, the extremities of the object will be feen in the lines rQ, rT, produced, and under the optic angle QrT, which is larger than ArB, and therefore the apparent magnitude of the object will be increafed. 3. Let GHI be a pencil of rays flowing from the point G; as it is the property of this lens to render diverging rays lefs diverging, parallel, or converging, it is evident, that fome of thofe rays, which would proceed on to M and N, and mifs the eye, were they to fuffer no refraction in paffing through the lens, will now enter it; by which means the object will appear brighter. 3. As to the apparent diftance of the object, that will vary according to the fituation of it with refpect to the focus of parallel rays of the lens. 1. Then, let us fuppofe the object placed fo much nearer the lens than its focus of parallel rays, that the refracted rays KE and LF, though rendered lefs diverging by paffing through it, may yet have a confiderable degree of divergency, fo that we may be able to form a judgment of the diftance of the object thereby. In this cafe, the object ought to appear where EK, FL, produced back concur; which, becaufe they diverge lefs than the rays GH, GI, will be beyond G, that is, at a greater diftance from the lens than the object is. But becaufe both the brightnefs and magnitude of the object will at the fame time be augmented, prejudice will not permit us to judge it quite fo far off as the point where thofe lines meet, but fomewhere between that point and its proper place. 2. Let the object be placed in the focus of parallel rays, then will the rays KE and LF become parallel; and though in this cafe the object would appear at an immenfe diftance, if that diftance were to be judged of by the direction of the rays KE and LF, yet upon account of the brightnefs and magnitude of it, we fhall not think it much farther from us than if it were feen by the naked eye. 3. If the object be fituated beyond the focus of parallel rays, as in BA (fig. 6.) the rays flowing from thence and falling upon the lens CD, will be collected into their refpective foci at a and b, and the intermediate points m, n, &c. and will there form an image of the object AB; and after croffing each other in the feveral points of it, as expreffed in the figure, will pafs on diverging as from a real object. Now if an eye be fituated at c, where Ac, Bc, rays proceeding from the extreme points of the object, make not a much larger angle AcB, than they would do if there were no lens interpofed, and the rays belonging to the fame pencil do not converge fo much as thofe the eye would receive if it were placed nearer to a or b, the object upon thefe accounts appearing very little larger or brighter than with the naked eye, is feen nearly in its proper place; but if the eye recedes a little way towards ab, the object then appearing both brighter and larger, feems to approach the lens: which is an evident proof of what has been fo often afferted, viz. that we judge of the diftance of an object in fome meafure by its brightnefs and magnitude; for the rays converge the more the farther the eye recedes from the lens; and therefore if we judged of the diftance of the object by the direction of the rays which flow from it, we ought in this cafe to conceive it at a greater diftance, than when the rays were parallel, or diverged at their entrance into the eye.

That the object fhould feem to approach the lens in this cafe, was a difficulty that exceedingly puzzled the learned Barrow, and which he pronounces infuperable, and not to be accounted for by any theory we have of vifion. Molineux alfo leaves it to the folution of others, as that which will be inexplicable, till a more intimate knowledge of the vifive faculty, as he expreffes it, be obtained by mortals.

They imagined, that feeing an object appears farther off, the lefs the rays diverge which fall upon the eye: if they fhould proceed parallel to each other, it ought to appear exceeding remote; and if they fhould converge, it fhould then appear more diftant ftill: the reafon of this was, becaufe they looked upon the apparent place of an object, as owing only to the direction of the rays whatever it was, and not at all to its apparent magnitude or fplendor.

Perhaps it may proceed from our judging of the diftance of an object in fome meafure by its magnitude, that that deception of fight commonly obferved by travellers may arife; viz. that upon the firft appearing of a building larger than ufual, as a cathedral church, or the like, it generally feems nearer to them, than they afterwards find it to be.

Prop. IV. If an object be placed farther from a convex lens than its focus of parallel rays, and the eye be fituated farther from it on the other fide than the place where the rays of the feveral pencils are collected into their refpective foci, the object appears inverted, and pendulous in the air, between the eye and the lens.

To explain this, let AB (fig. 6.) reprefent the object, CD the lens; and let the rays of the pencil ACD be collected in a, and thofe of BCD in b, forming there an inverted image of the object AB, and let the eye be placed in F: it is apparent from the figure, that fome of the refracted rays which pafs thro' each point of the image, will enter the eye as from a real object in that place; and therefore the object AB will appear there, as the propofition afferts. But we are fo little accuftomed to fee objects in this manner, that it is very difficult to perceive the image with one eye; but if both eyes are fituated in fuch a manner, that rays flowing from each point of the image may enter both, as at G and H, and we direct our optic axes to the image, it is eafy to be perceived.

If the eye be fituated in a or b, or very near them on either fide, the object appears exceedingly confufed, viz. if at d, the rays which proceed from the fame point of the object converge fo very much, and if at e, they diverge fo much, that they can-

Of Reflection.

not be collected together upon the retina, but fall upon it as if they were the axes of so many distinct pencils coming through every point of the lens; wherefore little more than one single point of the object is seen at a time, and that appears all over the lens; from whence nothing but confusion arises.

If the lens be so large that both eyes may be applied to it, as in *h* and *k*, the object will appear double; for it is evident from the figure, that the rays which enter the eye at *h* from either extremity of the object A or B, do not proceed as from the same point with that from whence those which enter the other at *k* seem to flow; the mind therefore is here deceived, and looks upon the object as situated in two different places, and therefore judges it to be double.

Prop. V. An object seen through a concave lens appears nearer, smaller, and less bright, than with the naked eye.

Plate CCXI.

Thus, let AB (fig. 7.) be the object, CD the pupil of an eye, and EF the lens. Now, as it is the property of a lens of this form, to render diverging rays more so, and converging ones less so, the diverging rays GH, GI, proceeding from the point G, will be made to diverge more, and so to enter the eye as from some nearer point *g*; and the rays AH, BI, which converge, will be made to converge less, and to enter the eye as from the points *a* and *b*; wherefore the object will appear in the situation *agb*, less and nearer than without the lens. Farther, as the rays which proceed from G are rendered more diverging, some of them will be made to pass by the pupil of the eye, which otherwise would have entered it, and therefore each point of the object will appear less bright.

Prop. VI. An object seen thro' a polygonous glass, that is, such as is terminated by several plain surfaces, is multiplied thereby.

For instance, let A (fig. 8.) be an object, and BC a polygonous glass terminated by the plain surfaces BD, DE, &c. and let the situation of the eye F be such, that the rays AB being refracted in passing thro' the glass, may enter it in the direction BF, and the rays AC in the direction CF. Then will the eye, by means of the former, see the object in G, and by the latter in H; and by means of the rays AI, the object will appear also in its proper situation A.

Sect. II. *Of the Reflection of Light.*

When a ray of light falls upon any body, however transparent, the whole of it never passes through the body, but some part is always driven back or reflected from it; and it is by this reflected light that all bodies which have no light of their own become visible to us. Of that part of the ray which enters, another part is also reflected from the second surface, or that which is farthest from the luminous body. When this part arrives again at the first surface, part of it is reflected back from that surface; and thus it continues to be reflected between the two surfaces, and to pass backwards and forwards within the substance of the medium, till some part is totally extinguished and lost. Besides this inconsiderable quantity, however, which is lost in this manner, the second surface often reflects much more than the first; insomuch that, in certain positions, scarce any rays will pass through both sides of the medium. A very considerable quantity is also unaccountably lost or extinguished at each reflecting surface; insomuch that no body, however transparent, can transmit all the rays which fall upon it; neither, tho' it be ever so well fitted for reflection, will it reflect them all.

§ 1. *Of the Cause of Reflection.*

The reflection of light is by no means so easily accounted for as the refraction of the same fluid. This property, as we have seen in the last section, may be accounted for in a satisfactory manner by the supposition of an attractive power diffused throughout the medium, and extending a very little way beyond it; but with regard to the reflection of light, there seems to be no satisfactory hypothesis hitherto invented. Of the principal opinions on this subject Mr Rowning hath given us the following account.

I. It was the opinion of philosophers before Sir Isaac Newton discovered the contrary, that light is reflected by impinging upon the solid parts of bodies. But that it is not so, is clear for the following reasons.

127 Light is not reflected by impinging on the solid parts of bodies at the first surface.

And first, it is not reflected at the first surface of a body by impinging against it.

For it is evident, that in order to the due and regular reflection of light, that is, that the reflected rays should not be dispersed and scattered one from another, there ought to be no rasures or unevenness in the reflecting surface large enough to bear a sensible proportion to the magnitude of a ray of light; because if the surface abounds with such, the reflected rays will rather be scattered like a parcel of pebbles thrown upon a rough pavement, than reflected with that regularity with which light is observed to be from a well-polished surface. Now those surfaces, which to our senses appear perfectly smooth and well polished, are far from being so; for to polish, is no other than to grind off the larger eminences and protuberances of the metal with the rough and sharp particles of sand, emery, or putty, which must of necessity leave behind them an infinity of rasures and scratches, which, tho' inconsiderable with regard to the former roughnesses, and too minute to be discerned by us, must nevertheless bear a large proportion to, if not vastly exceed, the magnitude of the particles of light.

128 Nor at the second.

Secondly, it is not reflected at the second surface, by impinging against any solid particles.

That it is not reflected by impinging upon the solid particles which constitute this second surface, is sufficiently clear from the foregoing argument; the second surfaces of bodies being as uncapable of a perfect polish as the first; and it is farther confirmed from hence, *viz.* that the quantity of light reflected differs according to the different density of the medium behind the body: And that it is not reflected by impinging upon the particles which constitute the surface of the medium behind it, is evident, because the strongest reflection of all at the second surface of a body, is when there is a vacuum behind it. This therefore wants no farther proof.

129 Supposition of a repulsive force.

II. It has been thought by some, that it is reflected at the first surface of a body, by a repulsive force equally diffused over it; and at the second, by an attractive force.

1. If

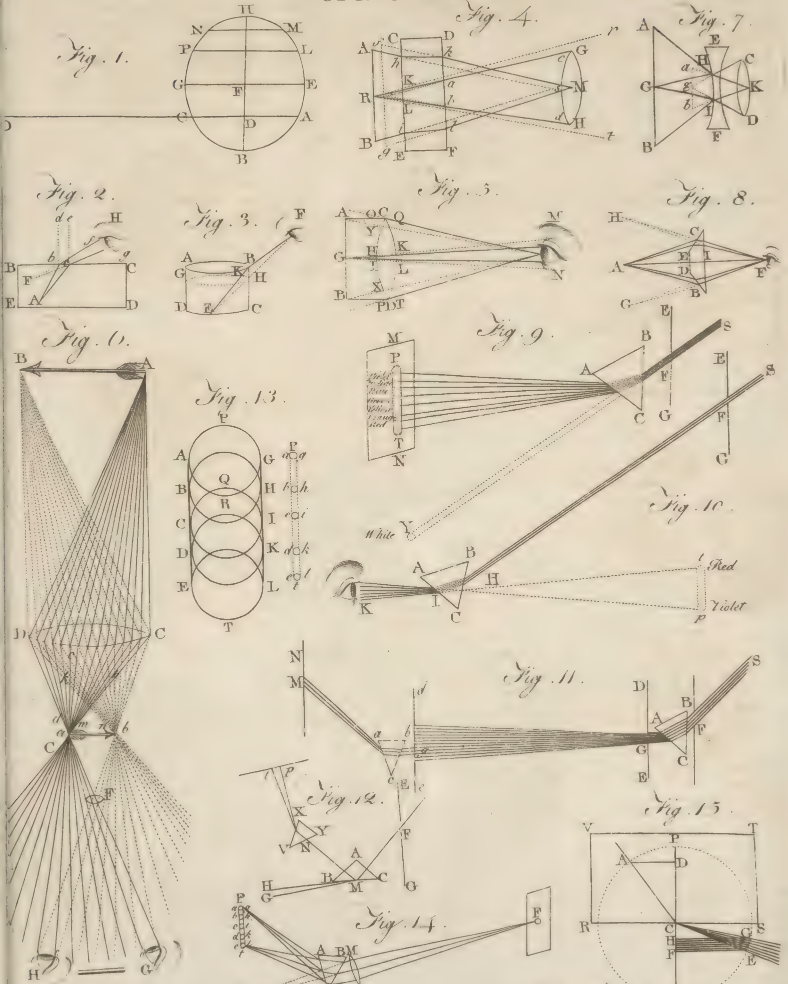
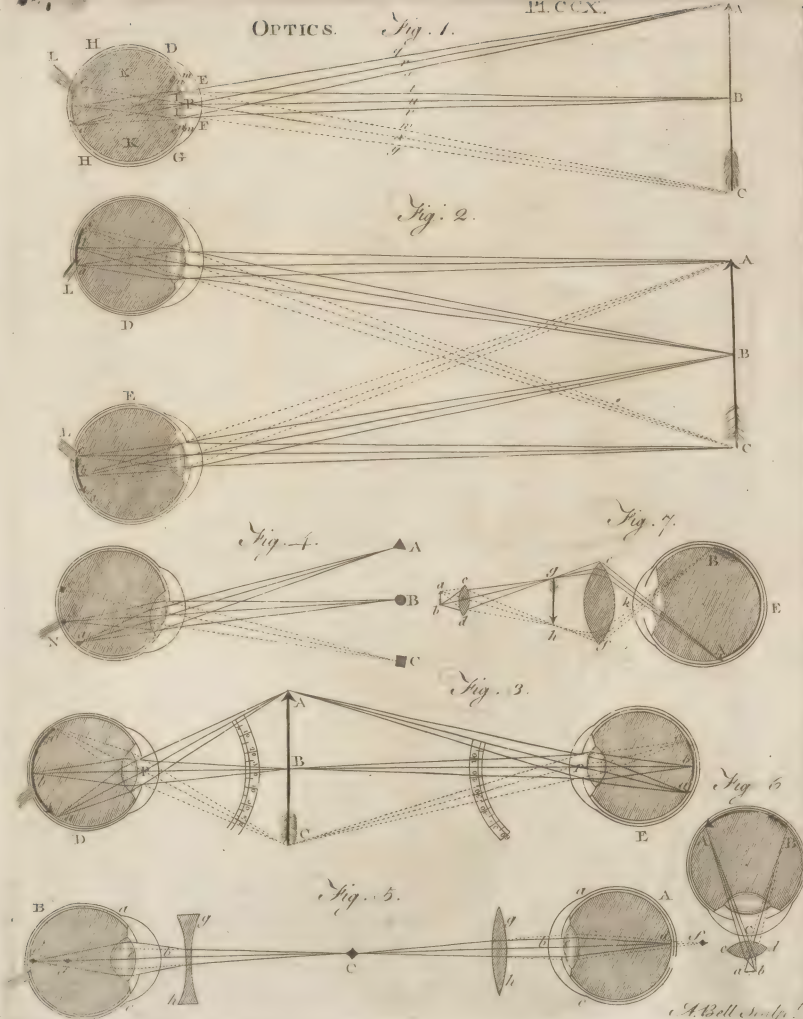


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.
White
Red
Violet

A. Bell Sculp.

OPTICS. Pl. CCX.



A. Bell Sculp.

Of Reflection.

130 Objected to.

1. If there be a repulfive force diffufed over the furface of bodies that repels rays of light at all times, then, fince by increafing the obliquity of a ray we diminifh its perpendicular force (which is that only, whereby it muft make its way through this repulfive force), however weakly that force may be fuppofed to act, rays of light may be made to fall with fo great a degree of obliquity on the reflecting furface, that there fhall be a total reflection of them there, and not one particle of light be able to make its way through: which is contrary to obfervation; the reflection of light at the firft furface of a tranfparent body being never total in any obliquity whatever. The hypothefis therefore in this particular muft be falfe.

131 Attractive force fuppofed.

2. As to the reflection at the fecond furface by the attractive force of the body; this may be confidered in two refpects: firft, when the reflection is total; fecondly, when it is partial.

And firft, in cafes where the reflection is total, the caufe of it is undoubtedly that fame attractive force by which light would be refracted in paffing out of the fame body. This is manifeft from that analogy which is obfervable between the reflection of light at this fecond furface, and its refraction there. For otherwife, what can be the reafon that the total reflection fhould begin juft when the obliquity of the incident ray, at its arrival at the fecond furface, is fuch, that the refracted angle ought to be a right one; or when the ray, were it not to return in reflection, ought to pafs on parallel to the furface, without going from it? For in this cafe it is evident, that it ought to be returned by this very power, and in fuch manner that the angle of reflection fhall be equal to the angle of incidence: juft as a ftone thrown obliquely from the earth, after it is fo far turned out of its courfe by the attraction of the earth, as to begin to move horizontally, or parallel to the furface of the earth, is then by the fame power made to return in a curve fimilar to that which is defcribed in its departure from the earth, and fo falls with the fame degree of obliquity that it was thrown with.

But fecondly, as to the reflection at the fecond furface, when it is partial; an attractive force uniformly fpread over it, as the maintainers of this hypothefis conceive it to be, can never be the caufe thereof. Becaufe it is inconceivable, that the fame force, acting in the fame circumftances in every refpect, can fometimes reflect the violet coloured rays and tranfmit the red, and at other times reflect the red and tranfmit the violet.

This argument concludes equally againft a repulfive force uniformly diffufed over the firft furface of a body, and reflecting light there; becaufe fome bodies reflect the violet and tranfmit the red, others reflect the red and tranfmit the violet, at their firft furface; which cannot poffibly be upon this fuppofition, the rays of whichever of thefe colours we fuppofe to be the ftrongeft.

132 Another ypothefis.

III. Some, being apprehenfive of the infufficiency of a repulfive and attractive force diffufed over the furfaces of bodies and acting uniformly, have fuppofed, that, by the action of light upon the furface of bodies, the matter of thefe forces is put into an undulatory motion; and that where the furface of it is fubfiding light is tranfmitted, and in thofe places where it is rifing light is reflected. But this feems not to advance us one jot farther; for in thofe cafes, fuppofe where red is reflected and violet tranfmitted, how comes it to pafs that the red impinges only on thofe parts when the waves are rifing, and the violet when they are fubfiding?

133 Sir Ifaac Newton's hypothefis.

IV. The next hypothefis that we fhall take notice of, is that remarkable one of Sir Ifaac Newton's fits of eafy reflection and tranfmiffion, which we fhall now explain and examine.

That author, as far as we can apprehend his meaning in this particular, is of opinion, that light, in its paffage from the luminous body, is difpofed to be alternately reflected by and tranfmitted through any refracting furface it may meet with; that thefe difpofitions (which he calls *fits of eafy reflection and eafy tranfmiffion)* return fucceffively at equal intervals: and that they are communicated to it at its firft emiffion out of the luminous body it proceeds from, probably by fome very fubtle and elaftic fubftance diffufed through the univerfe, and that in the following manner. As bodies falling into water, or paffing through the air, caufe undulations in each, fo the rays of light may excite vibrations in this elaftic fubftance. The quicknefs of which vibrations depending on the elafticity of the medium (as the quicknefs of the vibrations in the air, which propagate found, depend folely on the elafticity of the air, and not upon the quicknefs of thofe in the founding body) the motion of the particles of it may be quicker than that of the rays: and therefore, when a ray at the inftant it impinges upon any furface, is in that part of a vibration of this elaftic fubftance which confpires with its motion, it it may be eafily tranfmitted; and when it is in that part of a vibration which is contrary to its motion, it may be reflected. He farther fuppofes, that when light falls upon the firft furface of a body, none is reflected there; but all that happens to it there is, that every ray that is not in a fit of eafy tranfmiffion is there put into one, fo that when they come at the other fide (for this elaftic fubftance, eafily pervading the pores of bodies, is capable of the fame vibrations within the body as without it) the rays of one colour fhall be in a fit of eafy tranfmiffion, and thofe of another in a fit of eafy reflection, according to the thicknefs of the body, the intervals of the fits being different in rays of a different kind. This very well accounts for the different colours of the bubble and thin plate of air and water, as is obvious enough; and likewife for the reflection of light at the fecond furface of a thicker body; for the light reflected from thence is alfo obferved to be coloured, and to form rings according to the different thicknefs of the body, when not intermixed and confounded with other light, as will appear from the following experiment. If a piece of glafs be ground concave on one fide and convex on the other, both its concavity and convexity having one common centre; and if a ray of light be made to pafs through a fmall hole in a piece of paper held in that common centre, and be permitted to fall on the glafs; befides thofe rays which are regularly reflected back to the hole again, there will be others reflected to the paper, and form coloured rings furrounding the hole, not unlike thofe occafioned by the reflection of light from thin plates.

The fame will happen if the rays be reflected from a metalline fpeculum, but the light will not be coloured; which fhews, that the colours arife from that light which is reflected from the back-fide, and that in the following manner: Befides that light which is regularly reflected from the farther furface of the glafs, there is fome reflected irregularly, which, paffing from the back furface under the different obliquities, does as it were pafs through glaffes of different thickneffes, and therefore is in part reflected back again when it comes to the firft furface, and is in part tranfmitted through it, the tranfmited light, when received upon the white paper, exhibiting the rings of colours abovementioned.

As to the light which is fuppofed to be reflected at the firft furface, his opinion feems to be, That it is not there reflected, but that it really enters the furface, and is reflected from the back-fide of the firft feries of particles that lie therein: fo that, according as thefe particles are larger or fmaller, the rays of light which at their entrance into them (for they are tranfparent, whether the body they compofe be fo or not) are thereby put into fits of eafy tranfmiffion, at their emerfion at the other fide are fome in a fit of eafy tranfmiffion, others in a fit of eafy reflection, according as the interval of their fits are large or fmall. So that the particles of a body may be of fuch a fize that they fhall reflect the red and tranfmit the violet, or that they may reflect the violet and tranfmit the red; or, in general, that the ftrongeft and moft forcible rays may be tranfmitted while the weaker are reflected; or the weaker may be tranfmitted while the ftronger are reflected.

§. 2. *Of the Laws of Reflection.*

The fundamental law of the reflection of light is, that in all cafes the angle of reflection is equal to the angle of incidence. This is found by experiment to be the cafe, and befides may be demonftrated mathematically from the laws of percuffion in bodies perfectly elaftic. The axiom therefore holds good in every cafe of reflection, whether it be from plain furfaces or fpherical ones, and that whether they are convex or concave; and hence the feven following propofitions relating to the reflection of light from plain and fpherical furfaces may be deduced.

I. Rays of light reflected from a plain furface have the fame degree of inclination to one another that their refpective incident ones have.—For the angle of reflection of each ray being equal to that of its refpective incident one, it is evident, that each reflected ray will have the fame degree of inclination to that portion of the furface from whence it is reflected that its incident one has: but it is here fuppofed, that all thofe portions of furface from whence the rays are reflected, are fituated in the fame plain; confequently the reflected rays will have the fame degree of inclination to each other that their incident ones have, from whatever part of the furface they are reflected.

II. Parallel rays reflected from a concave furface are rendered converging.—To illuftrate this, let AF, CD, EB, (fig. 1.) reprefent three parallel rays falling upon the concave furface FB, whofe centre is C. To the points F and B draw the lines CF, CB; thefe being drawn from the centre, will be perpendicular to the furface at thofe points. The incident ray CD alfo paffing through the centre, will be perpendicular to the furface, and therefore will return after reflection in the fame line; but the oblique rays AF and EB will be reflected into the lines FM and BM, fituated on the contrary fide of their refpective perpendiculars CF and CB. They will therefore proceed converging after reflection towards fome point, as M, in the line CD.

Plate CCXII.

III. Converging rays falling on the like furface, are made to converge more.—For, every thing remaining as above, let GF, HB, be the incident rays. Now, becaufe thefe rays have larger angles of incidence than the parallel ones AF and EB in the foregoing cafe, their angles of reflection will alfo be larger than thofe of the others; they will therefore converge after reflection, fuppofe in the lines FN and BN, having their point of concourfe N farther from the point C than M, that to which the parallel rays AF and EB converged to in the foregoing cafe; and their precife degree of convergency will be greater than that wherein they converged before reflection.

IV. Diverging rays falling upon the like furface, are, after reflection, parallel, diverging, or converging. If they diverge from the focus of parallel rays, they then become parallel; if from a point nearer to the furface than that, they will diverge, but in a lefs degree than before reflection; if from a point between that and the centre, they will converge after reflection, and that to fome point on the contrary fide of the centre, but fituated farther from it than the point from which they diverged. If the incident rays diverge from a point beyond the centre, the reflected ones will converge to one on the other fide of it, but nearer to it than the point they diverged from; and if they diverge from the centre, they will be reflected thither again.

1. Let them diverge in the lines MF, MB, proceeding from M, the focus of parallel rays; then, as the parallel rays AF and EB were reflected into the lines FM and BM, (by Prop. II.) thefe rays will now on the contrary be reflected into them.

2. Let them diverge from N, a point nearer to the furface than the focus of parallel rays, they will then be reflected into the diverging lines FG and BH, which the incident rays GF and HB defcribed that were fhewn to be reflected into them in the foregoing propofition; but the degree wherein they diverge will be lefs than that wherein they diverged before reflection.

3. Let them proceed diverging from X, a point between the focus of parallel rays and the centre; they then make lefs angles of incidence than the rays MF and MB, which became parallel by reflection: they will confequently have lefs angles of reflection, and proceed therefore converging towards fome point, as Y; which point will always fall on the contrary fide of the centre, becaufe a reflected ray always falls on the contrary fide of the perpendicular with refpect to that on which its incident one falls; and of confequence it will be farther diftant from the centre than X.

4. If the incident ones diverge from Y, they will, after reflection, converge to X; thofe which were the incident rays in the former cafe being the reflected ones

Plate CCXII.

ones in this. And, laftly,

5. If the incident rays proceed from the centre, they fall in with their refpective perpendiculars; and for that reafon are reflected thither again.

V. Parallel rays reflected from a convex furface, are rendered diverging.—For, let AB, GD, EF, (fig. 2.) be three parallel rays falling upon the convex furface BF, whofe centre of convexity is C, and let one of them, viz. GD, be perpendicular to the furface. Through B, D, and F, the points of reflection, draw the lines CV, CG, and CT; which, becaufe they pafs through the centre, will be perpendicular to the furface at thefe points. The incident ray GD being perpendicular to the furface, will return after reflection in the fame line, but the oblique ones AB and EF in the lines BK and FL fituated on the contrary fide of their refpective perpendiculars BV and FT. They will therefore diverge, after reflection, as from fome point M in the line GD produced; and this point will be in the middle between D and C.

VI. Diverging rays reflected from the like furface, are rendered more diverging.—For, every thing remaining as above, let GB, GF, be the incident rays. Thefe having larger angles of incidence than the parallel ones AB and EF in the preceding cafe, their angles of reflection will alfo be larger than theirs: they will therefore diverge after reflection, fuppofe in the lines BP and FQ, as from fome point N, farther from C than the point M; and the degree wherein they will diverge will be greater than that wherein they diverged before reflection.

VII. Converging rays reflected from the like furface, are parallel, converging, or diverging. If they tend towards the focus of parallel rays, they then become parallel; if to a point nearer the furface than that, they converge, but in a lefs degree than before reflection; if to a point between that and the centre, they will diverge after reflection, as from fome point on the contrary fide of the centre, but fituated farther from it than the point they converged to: if the incident rays converge to a point beyond the centre, the reflected ones will diverge as from one on the contrary fide of it, but nearer to it than the point to which the incident ones converged; and if the incident rays converge towards the centre, the reflected ones will proceed as from thence.

1. Let them converge in the lines KB and LF, tending towards M, the focus of parallel rays; then, as the parallel rays AB EF were reflected into the lines BK and FL (by Prop. V.), thofe rays will now on the contrary be reflected into them.

2. Let them converge in the lines PB, QF, tending towards N a point nearer the furface than the focus of parallel rays, they will then be reflected into the converging lines BG and FG, in which the rays GB GF proceeded that were fhewn to be reflected into them by the laft propofition: but the degree wherein they will converge will be lefs than that wherein they converged before reflection.

3. Let them converge in the lines RB and SF proceeding towards X, a point between the focus of parallel rays and the centre; their angles of incidence will then be lefs than thofe of the rays KB and LF, which became parallel after reflection: their angles of reflection will therefore be lefs; on which account they muft neceffarily diverge, fuppofe in the lines BH and FI, from fome point, as Y; which point, (by Prop. IV.) will fall on the contrary fide of the centre with refpect to X, and will be farther from it than that.

4. If the incident rays tend towards Y, the reflected ones will diverge as from X; thofe which were the incident ones in one cafe, being the reflected ones in the other.

5. Laftly, if the incident rays converge towards the centre, they fall in with their refpective perpendiculars; on which account they proceed after reflection as from the centre.

We have already obferved, that in fome cafes there is a very great reflection from the fecond furface of a tranfparent body. The degree of inclination neceffary to caufe a total reflection of a ray at the fecond furface of a medium, is that which requires that the refracted angle (fuppofing the ray to pafs out there) fhould be equal to or greater than a right one; and confequently it depends on the refractive power of the medium through which the ray paffes, and is therefore different in different media. When a ray paffes through glafs furrounded with air, and is inclined to its fecond furface under an angle of 42 degrees or more, it will be wholly reflected there. For, as 11 is to 17, (the ratio of refraction out of glafs into air), fo is the fine of an angle of 42 degrees to a fourth number, that will exceed the fine of a right angle. From hence it follows, that when a ray of light arrives at the fecond furface of a tranfparent fubftance with as great, or a greater degree of obliquity, than that which is neceffary to make a total reflection, it will there be all returned back to the firft; and if it proceeds towards that with as great an obliquity as it did towards the other, (which it will do if the furfaces of the medium be parallel to each other), it will there be all reflected again, &c. and will therefore never get out, but pafs from fide to fide, till it be wholly fuffocated and loft within the body.—From hence may arife an obvious inquiry, how it comes to pafs, that light falling very obliquely upon a glafs widow from without, fhould be tranfmitted into the room? In anfwer to this it muft be confidered, that however obliquely a ray falls upon the furface of any medium whofe fides are parallel, (as thofe of the glafs in a window are), it will fuffer fuch a degree of refraction in entering there, that it fhall fall upon the fecond with a lefs obliquity than that which is neceffary to caufe a total reflection. For inftance, let the medium be glafs, as fuppofed in the prefent cafe; then, as 17 is to 11, (the ratio of refraction out of air into glafs), fo is the fine of the largeft angle of incidence with which a ray can fall upon any furface to the fine of a lefs angle than that of total reflection. And therefore, if the fides of the glafs be parallel, the obliquity with which a ray falls upon the firft furface, cannot be fo great, but that it fhall pafs the fecond without fuffering a total reflecton there.

When light paffes out of a denfer into a rarer medium, the nearer the fecond medium approaches the firft in denfity (or more properly in its refractive power), the lefs of it will be refracted in paffing from one to the other; and when their refracting powers are equal,

Of Reflection.

equal, all of it will paſs into the ſecond medium.

The above propoſitions may be all mathematically demonſtrated in the following manner.

Prop. I. Of the reflection of rays from a plain ſurface.

"When rays fall upon a plain ſurface, if they diverge, the focus of the reflected rays will be at the ſame diſtance behind the ſurface, that the radiant point is before it: if they converge, it will be at the ſame diſtance before the ſurface, that the imaginary focus of the incident rays is behind it."

This propoſition admits of two caſes.

Case 1. Of diverging rays.

Plate CCXII.

Dem. Let AB, AC, (fig. 3.) be two diverging rays incident on the plain ſurface DE, the one perpendicularly, the other obliquely: the perpendicular one AB will be reflected to A, proceeding as from ſome point in the line AB produced; the oblique one AC will be reflected into ſome line as CF, ſuch that the point G, where the line FG produced interſects the line AB produced alſo, ſhall be at an equal diſtance from the ſurface DE with the radiant A. For the perpendicular CH being drawn, ACH and HCF will be the angles of incidence and reflection; which being equal, their complements ACB and FCE are ſo too: but the angle BCG is equal to FCE, as being vertical to it: therefore in the triangles ABC and GBC the angles at C are equal, the ſide BC is common, and the angles at B are alſo equal to each other, as being right ones; therefore the lines AB and BG, which reſpect the equal angles at C, are alſo equal; and conſequently the point G, the focus of the incidents rays AB, AC, is at the ſame diſtance behind the ſurface, that the point A is before it. *Q. E. D.*

Case 2. Of converging rays.

This is the converſe of the former caſe. For ſuppoſing FC and AB to be two converging incident rays, CA and BA will be the reflected ones (the angles of incidence in the former caſe being now the angles of reflection, and *vice verſa*), having the point A from their focus; but this, from what was demonſtrated above, is at an equal diſtance from the reflecting ſurface with the point G, which in this caſe is the imaginary focus of the incident rays, FC, and AB.

Obs. It is not here, as in the refraction of rays in paſſing through a plain ſurface, where ſome of the refracted rays proceed as from one point, and ſome as from another: but they all proceed after reflection as from one and the ſame point, however obliquely they may fall upon the ſurface; for what is here demonſtrated of the ray AC holds equally of any other, as AI, AK, &c.

The caſe of parallel rays incident on a plain ſurface, is included in this propoſition: for in that caſe we are to ſuppoſe the radiant to be at an infinite diſtance from the ſurface, and then by the propoſition the focus of the reflected rays will be ſo too; that is, the rays will be parallel after reflection, as they were before.

Prop. II. Of the reflection of parallel rays from a ſpherical ſurface.

"When parallel rays are incident upon a ſpherical ſurface, the focus of the reflected rays will be the middle point between the centre of convexity and the ſurface."

This propoſition admits of two caſes.

Case 1. Of parallel rays falling upon a convex ſurface.

Dem. Let AB, DH, (fig. 4.) repreſent two parallel rays incident on the convex ſurface BH, the one perpendicularly, the other obliquely; and let C be the centre of convexity; ſuppoſe HE to be the reflected ray of the oblique incident one DH proceeding as from F, a point in the line AB produced. Through the point H draw the line CI, which will be perpendicular to the ſurface at that point; and the angles DHI and IHF, being the angles of incidence and reflection, will be equal. To the former of theſe, the angle HCF is equal, the lines AC and DH being parallel, and to the latter the angle CAF as being vertical; wherefore the triangle CFH is iſoſceles, and conſequently the ſides CF and FH are equal: but ſuppoſing BH to vaniſh, FH is equal to FB; and therefore upon this ſuppoſition FC and FB are equal, that is, the focus of the reflected rays is the middle point between the centre of convexity and the ſurface. *Q. E. D.*

Case 2. Of parallel rays falling upon a concave ſurface.

Dem. Let AB, DH (fig. 5.) be two parallel rays incident, the one perpendicularly, the other obliquely, on the concave ſurface BH, whoſe centre of concavity is C. Let BF and HF be the reflected rays meeting each other in F; this will be the middle point between B and C. For drawing through C the perpendicular CH, the angles DHC and FHC, being the angles of incidence and reflection, will be equal, to the former of which the angle HCF is equal, as alternate; and therefore the triangle CFH is iſoſceles. Wherefore CF and FH are equal: but if we ſuppoſe BH to vaniſh, FB and FH are alſo equal, and therefore CF is equal to FB; that is, the focal diſtance of the reflected rays is the middle point between the centre and the ſurface. *Q. E. D.*

Obs. It is here obſervable, that the farther the line DH, either in fig. 4. or 5. is taken from AB, the nearer the point F falls to the ſurface. For the farther the point H recedes from B, the larger the triangle CFH will become; and conſequently, ſince it is always an iſoſceles one, and the baſe CH, being the radius, is every where of the ſame length, the equal legs CF and FH will lengthen; but CF cannot grow longer unleſs the point F approach towards the ſurface. And the farther H is removed from B, the faſter F approaches to it.

This is the reaſon, that whenever parallel rays are conſidered as reflected from a ſpherical ſurface, the diſtance of the oblique one from the perpendicular one is taken ſo ſmall with reſpect to the focal diſtance of that ſurface, that without any phyſical error it may be ſuppoſed to vaniſh.

From hence it follows, that if a number of parallel rays, as AB, CD, EG, &c. fall upon a convex ſurface, (as fig. 6.) and if BA, DK, the reflected rays of the incident ones AB, CD, proceed as from the point F, thoſe of the incident ones CD, EG, viz. DK, GL, will proceed as from N, thoſe of the incident ones EG, HI, as from O, &c. becauſe the farther the incident ones CD, EG, &c. are from AB, the nearer to the ſurface are the points F, *f*, *f*, in the line BF, from which they proceed after reflection; ſo that properly the foci of the reflected rays BA, DK, GL, &c. are not

Of Reflection.

not in the line AB produced, but in a curve line passing thro' the points F, N, O, &c.

The same is applicable to the case of parallel rays reflected from a concave surface, as expressed by the pricked lines on the other half of the figure, where PQ, RS, TV, are the incident rays; QF, S*f*, V*f*, the reflected ones, intersecting each other in the points X, Y, and F; so that the foci of those rays are not in the line FB, but in a curve passing through those points.

Plate CCXII.

Had the surface BH in fig. 4. or 5. been formed by the revolution of a parabola about its axis having its focus in the point F, all the rays reflected from the convex surface would have proceeded as from the point F, and those reflected from the concave would have fallen upon it, however distant their incident ones AB, DH, might have been from each other. For in the parabola, all lines drawn parallel to the axis make angles with the tangents to the points where they cut the parabola (that is, with the surface of the parabola) equal to those which are made with the same tangents by lines drawn from thence to the focus; therefore, if the incident rays describe those parallel lines, the reflected ones will necessarily describe these other, and so will all proceed as from, or meet in, the same point.

Prop. III. Of the reflection of diverging and converging rays from a spherical surface.

" When rays fall upon any spherical surface, if they diverge, the distance of the focus of the reflected rays from the surface is to the distance of the radiant point from the same (or, if they converge, to that of the imaginary focus of the incident rays), as the distance of the focus of the reflected rays from the centre is to the distance of the radiant point (or imaginary focus of the incident rays) from the same."

This proposition admits of ten cases.

Case 1. Of diverging rays falling upon a convex surface.

Dem. Let RB, RD (fig. 7.) represent two diverging rays flowing from the point R as from a radiant, and falling the one perpendicularly, the other obliquely, on the convex surface BD, whose centre is C. Let DE be the reflected ray of the incident one RD, produce ED to F, and through R draw the line RH parallel to FE till it meets CD produced in H. Then will the angle RHD be equal to EDH the angle of reflection, as being alternate to it, and therefore equal also to RDH which is the angle of incidence; wherefore the triangle DRH is isosceles, and consequently DR is equal to RH. Now the lines FD and RH being parallel, the triangles FDC and RHC are similar, (or to express it in Euclid's way, the sides of the triangle RHC are cut proportionably, 2 Elem. 6.): and therefore FD is to RH, or its equal RD, as CF to CR; but BD vanishing, FD and RD differ not from FB and RB: wherefore FB is to RB also, as CF to CR; that is, the distance of the focus from the surface is to the distance of the radiant point from the same, as the distance of the focus from the centre is to the distance of the radiant from thence. *Q. E. D.*

Case 2. Of converging rays falling upon a concave surface.

Dem. Let KD and CB be the converging incident rays having their imaginary focus in the point R, which was the radiant in the foregoing case. Then as RD was in that case reflected into DE, KD will in this be reflected into DF; for, since the angles of incidence in both cases are equal, as they are by being vertical, the angles of reflection will be so too; so that F will be the focus of the reflected rays: but it was there demonstrated, that FB is to RB as CF to CR; that is, the distance of the focus from the surface is to the distance (in this Case) of the imaginary focus of the incident rays, as the distance of the focus from the centre is the distance of the imaginary focus of the incident rays from the same. *Q. E. D.*

Case 3. Of converging rays falling upon a convex surface, and tending to a point between the focus of parallel rays and the centre.

Dem. Let BD (fig. 8.) represent a convex surface whose centre is C, and whose focus of parallel rays is P; and let AB, KD, be two converging rays incident upon it, and having their imaginary focus at R, a point between P and C. Now because KD tends to a point between the focus of parallel rays and the centre, the reflected ray DE will diverge from some point on the other side the centre, suppose F; as explained above (p. 5547.) under prop. 7. Through D draw the perpendicular CD, and produce it to H; then will KDH and HDE be the angles of incidence and reflection, which being equal, their vertical ones RDC and CDF will be so too, and therefore the vertex of the triangle RDF is bisected by the line DC: wherefore (3 El. 6.) FD and DR or BD vanishing, FB and BR are to each other as FC to CR; that is, the distance of the focus of the reflected rays is to that of the imaginary focus of the incident ones, as the distance of the former from the centre is to the distance of the latter from the same. *Q. E. D.*

Case 4. Of diverging rays falling upon a concave surface, and proceeding from a point between the focus of parallel rays and the centre.

Dem. Let RB, RD, be the diverging rays incident upon the concave surface BD, having their radiant point in the point R, the imaginary focus of the incident rays in the foregoing case. Then as KD was in that case reflected into DE, RD will now be reflected into DF. But it was there demonstrated, that FB and RB are to each other, as CF to CR; that is, the distance of the focus is to that of the radiant, as the distance of the former from the centre is to the distance of the latter from the same. *Q. E. D.*

The angles of incidence and reflection being equal, it is evident, that if, in any case, the reflected ray be made the incident one, the incident will become the reflected one: and therefore the four following cases may be considered respectively as the converse of the four foregoing; for in each of them the incident rays are supposed to coincide with the reflected ones in the other. Or they may be demonstrated independently of them as follows.

Case 5. Of converging rays falling upon a convex surface, and tending to a point nearer the surface than the focus of parallel rays.

Dem. Let ED, RB (fig. 7.) be the converging rays incident upon the convex surface BD whose centre

Of Reflection.

tre is C, and focus of parallel rays is at P; and let the imaginary focus of the incident rays be at F, a point between P and B; and let DR be the reflected ray. From C and R draw the lines CH, RH, the one passing through D, the other parallel to FE. Then will the angle RHD be equal to HDE the angle of incidence, as alternate to it; and therefore equal to HDR, the angle of reflection: wherefore the triangle HDR is isosceles, and consequently DR is equal to RH. Now the lines FD and RH being parallel, the triangles FDC and RHC are similar; and therefore RH, or RD, is to FD as CR to CF: but BD vanishing, RD and FD coincide with RB and FB, wherefore RB is to FB as CR to CF; that is, the distance of the focus from the surface is to the distance of the imaginary focus of the incident rays, as the distance of the focus from the centre is to the distance of the imaginary focus of the incident rays from the same. *Q. E. D.*

Case 6. Of diverging rays falling upon a concave surface, and proceeding from a point between the focus of parallel rays and the surface.

Dem. Let FD and FB represent two diverging rays flowing from the point F as a radiant, which was the imaginary focus of the incident rays in the foregoing case. Then as ED was in that case reflected into DR, FD will be reflected into DK, (for the reason mentioned in Case the second), so that the reflected ray will proceed as from the point R: but it was demonstrated in the case immediately foregoing, that RB is to FB as CR to CF; that is, the distance of the focus from the surface is to that of the radiant from the same, as the distance of the former from the centre is to that of the latter from the same. *Q. E. D.*

Case 7. Of converging rays falling upon a convex surface, and tending towards a point beyond the centre.

Plate CCXII.

Dem. Let AB, ED, (fig. 8.) be the incident rays tending to F, a point beyond the centre C, and let DK be the reflected ray of the incident one ED. Then because the incident ray ED tends to a point beyond the centre, the reflected ray DK will proceed as from one on the contrary side, suppose R; as explained above under Prop. VII. Through D draw the perpendicular CD, and produce it to H. Then will EDH and HDK be the angles of incidence and reflection; which being equal, their vertical ones CDF and CDR will be so too: consequently the vertex of the triangle FDR is bisected by the line CD: wherefore, RD is to DF, or (3 Elem. 6.) BD vanishing, RB is to BF as RC to CF; that is, the distance of the focus of the reflected rays is to that of the imaginary focus of the incident rays, as the distance of the former from the centre is to the distance of the latter from the same. *Q. E. D.*

Case 8. Of diverging rays falling upon a concave surface, and proceeding from a point beyond the centre.

Dem. Let FB, FD, be the incident rays having their radiant in F, the imaginary focus of the incident rays in the foregoing case. Then as ED was in that case reflected into DK, FD will now be reflected into DR; so that R will be the focus of the reflected rays. But it was demonstrated in the foregoing case, that RB is to FB as RC to CF; that is, the distance of the focus of the reflected rays from the surface is to the distance of the radiant from the same, as the distance of the focus of the reflected rays from the centre is to the distance of the radiant from thence. *Q. E. D.*

The two remaining cases may be considered as the converse of those under Prop. II. (p. 5548.), because the incident rays in these are the reflected ones in them; or they may be demonstrated in the same manner with the foregoing, as follows.

Case 9. Converging rays falling upon a convex surface, and tending to the surface of parallel rays, become parallel after reflection.

Dem. Let ED, RB, (fig. 7.) represent two converging rays incident on the convex surface BD, and tending towards F, which we will now suppose to be the focus of parallel rays; and let DR be the reflected ray, and C the centre of convexity of the reflecting surface. Through C draw the line CD, and produce it to H, drawing RH parallel to ED produced to F. Now it has been demonstrated (Case 5.) where the incident rays are supposed to tend to the point F, that RB is to FB as RC to CF; but F in this Case being supposed to be the focus of parallel rays, it is the middle point between C and B (by proposition 2d), and therefore FB and FC are equal; and consequently the two other terms in the proportion, viz. RB and RC, must be so too; which can only be upon a supposition that R is at an infinite distance from B; that is, that the reflected rays BR and DR be parallel. *Q. E. D.*

Case 10. Diverging rays falling upon a concave surface, and proceeding from the focus of parallel rays, become parallel after reflection.

Dem. Let RD, RB (fig. 8.) be two diverging rays incident upon the concave surface BD, as supposed in Case 4.; where it was demonstrated that FB is to RB as CF to CR. But in the present case RB and CR are equal, because R is supposed to be the focus of parallel rays; therefore FB and FC are so too. Which cannot be unless F be taken at an infinite distance from B; that is, unless the reflected rays BF and DF be parallel. *Q. E. D.*

Obs. It is here observable, that in the case of diverging rays falling upon a convex surface, (see fig. 7.) the farther the point D is taken from B, the nearer the point F, the focus of the reflected rays, approaches to B, while the radiant R remains the same. For it is evident from the curvature of a circle, that the point D (fig. 9.) may be taken so far from B, that the reflected ray DE shall proceed as from F, G, H, or even from B, or from any point between B and R; and the farther it is taken from B, the faster the point from which it proceeds, approaches towards R: as will easily appear if we draw several incident rays with their respective reflected ones, in such manner that the angles of reflection may be all equal to their respective angles of incidence, as is done in the figure. The like is applicable to any of the other cases of diverging or converging rays incident upon a spherical surface. This is the reason, that when rays are considered as reflected from a spherical surface, the distance of the oblique rays from the perpendicular one is taken so small, that it may be supposed to vanish.

From

Of Reflection.

From hence it follows, that if a number of diverging rays are incident upon the convex surface BD at the several points B, D, D, &c. they shall not proceed after reflection as from any point in the line RB produced, but as from a curve line passing thro' the several points F, *f*, *f*, &c. The same is applicable in all the other cases.

Plate CCXII.

Had the curvature BD (fig. 7.) been hyperbolical, having its foci in R and F; then R being the radiant, (or the imaginary focus of incident rays), F would have been the focus of the reflected ones, and *vice versa*, however distant the points B and D might be taken from each other. In like manner, had the curve BD (fig. 8.) been elliptical, having its foci in F and R, the one of these being made the radiant (or imaginary focus of incident rays), the other would have been the focus of reflected ones, and *vice versa*. For both in the hyperbola and ellipsis, lines drawn from each of their foci through any point make equal angles with the tangent to that point. Therefore, if the incident rays proceed to or from one of their foci, the reflected ones will all proceed as from or to the other. So that, in order that diverging or converging rays may be accurately reflected to or from a point, the reflecting surface must be formed by the revolution of an hyperbola about its longer axis, when the incident rays are such, that their radiant, or imaginary focus of incident rays, shall fall on one side the surface, and the focus of the reflected ones on the other: when they are both to fall on the same side, it must be formed by the revolution of an ellipsis about its longer axis. However, upon account of the great facility with which spherical surfaces are formed in comparison of that with which surfaces formed by the revolution of any of the conic sections about their axes are made, the latter are very rarely used. Add to this another inconvenience, *viz.* that the foci of these curves being mathematical points, it is but one point of the surface of an object that can be placed in any of them at a time, so that it is only in theory that surfaces formed by the revolution of these curves about their axes render reflection perfect.

Now, because the focal distance of rays reflected from a spherical surface cannot be found by the analogy laid down in the third proposition, without making use of the quantity sought; we shall here give an instance whereby the method of doing it in all others will readily appear.

Prob. Let it be required to find the focal distance of diverging rays incident upon a convex surface, whose radius of convexity is 5 parts, and the distance of the radiant from the surface is 20.

Sol. Call the focal distance sought x; then will the distance of the focus from the centre be $5-x$, and that of the radiant from the same 25: therefore by prop. 3. we have the following proportion, *viz.* $x : 20 :: 5-x : 25$; and multiplying extremes together and means together, we have $25x = 100-20x$, which, after due reduction, gives $x=\frac{100}{45}$.

If in any case it should happen that the value of x should be a negative quantity, the focal point must then be taken on the contrary side the surface to that on which it was supposed that it would fall in stating the problem.

If letters instead of figures had been made use of in the foregoing solution, a general theorem might have been raised, to have determined the focal distance of reflected rays in all cases whatever. See this done in Suppl. to *Gregory's Optics*, 2d edit. p. 112.

Because it was, in the preceding section, observed, that different incident rays, though tending to or from one point, would after refraction proceed to or from different points, a method was there inserted of determining the distinct point, which each separate ray entering a spherical surface converges to, or diverges from, after refraction: the same has been observed here with regard to rays reflected from a spherical surface, (see obs. in case 2. and case 10.) But the method of determining the distinct point to or from which any given incident ray proceeds after reflection, is much more simple. It is only necessary to draw the reflected ray such, that the angle of reflection may be equal to the angle of incidence, which will determine the point it proceeds to or from in any case whatever.

§ 3. *Of the Appearance of Bodies seen by Light reflected from plane and spherical Surfaces.*

Whatever hath been said concerning the appearance of bodies seen by refracted light through lenses, respects also the appearance of bodies seen by reflection. But besides these, there is one thing peculiar to images by reflection, *viz.* that each point in the representation of an object made by reflection appears situated somewhere in an infinite right line that passes through its correspondent point in the object, and is perpendicular to the reflecting surface.

The truth of this appears sufficiently from the propositions formerly laid down; in each of which, rays flowing from any radiant point, are shewn to proceed, after reflection, to or from some point in a line that passes through the said radiant, and is perpendicular to the reflecting surface. For instance, (fig. 1.) rays flowing from Y are collected in X, a point in the perpendicular CD, which, being produced, passes through Y; again, (fig. 2.) rays flowing from from G, proceed, after reflection, as from N, a point in the perpendicular CD, which, being produced, passes thro' G; and so of the rest.

Plate CCXII.

This observation, however, except where an object is seen by reflection from a plain surface, relates only to those cases where the representation is made by means of such rays as fall upon the reflecting surface with a very small degree of obliquity; because such as fall at a considerable distance from the perpendicular, proceed not after reflection as from any point in that perpendicular, but as from other points situated in a certain curve, as hath already been explained; upon which account these rays are neglected, as making a confused and deformed representation. And therefore it is to be remembered, that however the situation of the eye with respect to the object and reflecting surface may be represented in the following figures, it is to be supposed as situated in such a manner with respect to the object, that rays flowing from thence and entering it after reflection, may be such only as fall with a very small degree of obliquity upon the surface; that is, the eye must be supposed to be placed almost directly behind the object, or between it and the reflecting surface. The reason why it is not always so placed, is only to avoid confusion in the figures.

Of Reflection.

I. When an object is seen by reflection from a plane surface, the image of it appears at the same distance behind the surface that the object is placed before it, of the same magnitude therewith, and directly opposite to it.

Plate CCXII.

To explain this, let AB (fig. 10.) represent an object seen by reflection from the plain surface SV; and let the rays AF, AG, be so inclined to the surface, that they shall enter an eye at H after reflection; and let AE be perpendicular to the surface: then, by the observation just mentioned, the point A will appear in some part of the line AE produced; suppose I, that is, the oblique rays AF and AG will proceed after reflection as from that point; and further, because the reflected rays FH, GK, will have the same degree of inclination to one another that their incident ones have, that point must necessarily be at the same distance from the surface that the point A is; the representation therefore of the point A, will be at the same distance behind the surface that the point itself is before it, and directly opposite to it: consequently, since the like may be shewn of the point B, or of any other, the whole image IM will appear at the same distance behind the surface that the object is before it, and directly opposite to it; and because the lines AI, BM, which are perpendicular to the plain surface, are for that reason parallel to each other, it will also be of the same magnitude therewith.

II. When an object is seen by reflection from a convex surface, its image appears nearer to the surface, and less than the object.

Let AB (fig. 12.) represent the object, SV a reflecting surface whose centre of convexity is C: and let the rays AF, AG, be so inclined to the surface, that after reflection thereat they shall enter the eye at H: and let AE be perpendicular to the surface: then will the oblique rays AF, AG, proceed after reflection as from some point in the line AE produced, suppose from I; which point, because the reflected rays will diverge more than the incident ones, must be nearer to the surface than the point A. And since the same is also true of the rays which flow from B, or any other point, the representation IM will be nearer to the surface than the object; and because it is terminated by the perpendiculars AE and BF which incline to each other, as concuring at the centre, it will also appear less.

III. When an object is seen by reflection from a concave surface, the representation of it is various, both with regard to its magnitude and situation, according as the distance of the object from the reflecting surface is greater or less.

1. When the object is nearer to the surface than its focus of parallel rays, the image falls on the opposite side of the surface, is more distant from it, and larger than the object.

Thus, let AB (fig. 13.) be the object, SV the reflecting surface, F the focus of parallel rays, and C its centre. Through A and B, the extremities of the object, draw the line CE, CR, which will be perpendicular to the surface; and let the rays AR, AG, be incident upon such points of it that they shall be reflected into an eye at H. Now, because the radiant points A and B are nearer the surface than F the focus of parallel rays, the reflected rays will diverge, and will therefore proceed as from some points on the opposite side the surface; which points, by the observation laid down at the beginning of this section, will be in the perpendiculars AE, BR, produced, suppose in I and M: but they will diverge in a less degree than their incident ones (see the proposition just referred to), and therefore the said points will be farther from the surface than the points A and B. The image therefore will be on the opposite side of the surface with respect to the object; it will be more distant than it; and consequently, being terminated by the perpendiculars CI and CM, it will also be larger.

Of Reflection.

2. When the object is placed in the focus of parallel rays, the reflected rays enter the eye parallel, in which case the image ought to appear at an infinite distance behind the reflecting surface; but the representation of it, for the like reasons that were given in the foregoing case, being large and distinct, we judge it not much farther from the surface than the image.

3. When the object is placed between the focus of parallel rays and the centre, the image falls on the opposite side the centre, is larger than the object, and in an inverted position.

Thus let AB (fig. 14.) represent the object, SV the reflecting surface, F its focus of parallel rays, and C its centre. Through A and B, the extremities of the object, draw the lines CE and CN, which will be perpendicular to the surface; and let AR, AG, be a pencil of rays flowing from A. These rays proceeding from a point beyond the focus of parallel rays will after reflection converge towards some point on the opposite side the centre, which will fall upon the perpendicular EC produced, but at a greater distance from C than the radiant A from which they diverged. For the same reason, rays flowing from B will converge to a point in the perpendicular NC produced, which shall be farther from C than the point B; from whence it is evident, that the image IM is larger than the object AB, that it falls on the contrary side the centre, and that their positions are inverted with respect to each other.

4. If the object be placed beyond the centre of convexity, the image is then formed between the centre, and the focus of parallel rays is less than the object, and its position is inverted.

The proposition is the converse of the foregoing: for as in that case rays proceeding from A were reflected to I, and from B to M; so rays flowing from I and M will be reflected to A and B; if therefore an object be supposed to be situated beyond the centre in IM, the image of it will be formed in AB between that and the focus of parallel rays, will be less than the object, and inverted.

5. If the middle of the object be placed in the centre of convexity of the reflecting surface, the object and its image will be coincident; but the image will be inverted with respect to the object.

That the place of the image and the object should be the same in this case needs little explication; for the middle of the object being in the centre, rays flowing from thence will fall perpendicularly upon the surface, and therefore necessarily return thither again; so that the middle of the image will be coincident with the

Of Reflection.

the middle of the object. But that the image should be inverted is perhaps not so clear. To explain this, let AB (fig. 15.) be the object, having its middle point C in the centre of the reflecting surface SV; through the centre and the point R draw the line CR, which will be perpendicular to the reflecting surface; join the points AR and BR, and let AR represent a ray flowing from A; this will be reflected into RB: for C being the middle point between A and B, the angles ARC and CRB are equal; and a ray from B will likewise be reflected to A; and therefore the position of the image will be inverted with respect to that of the object.

In this proposition it is to be supposed that the object AB is so situated with respect to the reflecting surface, that the angle ACR may be right; for otherwise the angles ARC and BRC will not be equal, and part of the image will therefore fall upon the object and part off.

6. If in any of the three last cases, in each of which the image is formed on the same side the reflecting surface with the object, the eye be situated farther from the surface than the place where the image falls, the rays of each pencil, crossing each other in the several points of the image, will enter the eye as from a real object situated there; so that the image will appear pendulous in the air between the eye and the reflecting surface, and in the position wherein it is formed, viz. inverted with respect to the object in the same manner that an image formed by refracted light appears to an eye placed beyond it; which was fully explained under Prop. IV. (p. 5543.) and therefore needs not be repeated here.

But as to what relates to the appearance of the object when the eye is placed nearer to the surface than the image, that was not there fully inquired into. That point shall therefore now be more strictly examined under the following case, which equally relates to refracted and reflected light.

7. If the eye be situated between the reflecting surface and the place of the image, the object is then seen beyond the surface; and the farther the eye recedes from the surface towards the place of the image, the more confused, larger, and nearer the object appears.

Plate CCXII.

To explain this, let AB (fig. 16.) represent the object; IM its image, one of whose points M is formed by the concurrence of the reflected rays DM, EM, &c. which before reflection came from B; the other, I, by the concurrence of DI, EI, &c. which came from A: and let ab be the pupil of an eye, situated between the surface DP and the image. This pupil will admit the rays Ha, Kb; which, because they are tending towards I, are such as came from A, and therefore the point A will appear diffused over the space RS. In like manner the pupil will also receive into it the reflected rays Ka and Lb, which, because they are tending towards M, by supposition came from B; and therefore the point B will be seen spread as it were over the space TV, and the object will seem to fill the space RV; but the representation of it will be confused, because the intermediate points of the object being equally enlarged in appearance, there will not be room for them between the points S and T, but they will coincide in part one with another: for instance, the appearance of that point in the object, whose representation falls upon c in the image, will fill the space mn; and so of the rest. Now if the same pupil be removed into the situation ef, the reflected rays Ee and Gf will then enter the eye, and therefore one extremity of the object will appear to cover the space XY; and because the rays Of and Le will also enter it in their progress towards M, the point B, from whence they came, will appear to cover ZV; the object therefore will appear larger and more confused than before. And when the eye recedes quite to the image, it sees but one single point of the object, and that appears diffused all over the reflecting surface: for instance, if the eye recedes to the point M, then rays flowing from the point B enter it upon whatever part of the surface they fall; and so for the rest. The object also appears nearer to the surface, the farther the eye recedes from it towards the place of the image; probably because, as the appearance of the object becomes more and more confused, its place is not so easily distinguished from that of the reflecting surface itself, till at last when it is quite confused (as it is when the eye is arrived at M) they both appear as one, the surface assuming the colour of the object.

As to the precise apparent magnitude of an object seen after this manner, it is such that the angle it appears under shall be equal to that which the image of the same object would appear under were we to suppose it seen from the same place: that is, the apparent object (for such we must call it to distinguish it from the image of the same object) and the image subtend equal angles at the eye.

Dem. Here we must suppose the pupil of the eye to be a point only, because the magnitude of that causes small alteration in the apparent magnitude of the object; as we shall see by and by. Let then the point a represent the pupil, then will the extreme rays that can enter it be Ha and Ka; the object therefore will appear under the angle HaK, which is equal to its vertical one MaI, under which the image IM would appear were it to be seen from a. Again, if the eye be placed in f, the object appears under the angle GfO equal to IfM, which the image subtends at the same place, and therefore the apparent object and image of it subtend equal angles at the eye. *Q. E. D.*

Now if we suppose the pupil to have any sensible magnitude, such, suppose, that its diameter may be ab; then the object seen by the eye in that situation will appear under the angle HxL, which is larger than the angle HaK, under which it appeared before; because the angle at x is nearer than the angle at a, to the line IM, which is a subtense common to them both.

From this proposition it follows, that, were the eye close to the surface at K, the real and apparent object would be seen under equal angles (for the real object appears from that place under the same angle that the image does, as will be shewn at the end of this section): therefore, when the eye is nearer to the image than that point, the image will subtend a larger angle at it than the object does; and consequently, since the image and apparent object subtend equal angles at the eye, the apparent object must necessarily be seen under a larger angle than the object itself, where-

Of Reflection.

wherever the eye be placed, between the furface and the image.

As each point in the reprefentation of an object made by reflection is fituated fomewhere in a right line that paffes through its correfpondent point in the object, and is perpendicular to the reflecting furface, as was fhewn in the beginning of this fection; we may from hence deduce a moft eafy and expeditious method of determining both the magnitude and fituation of the image in all cafes whatever. Thus,

Plate CCXII.

Through the extremities of the object AB and the centre C, (fig. 17, 18, or 19.) draw the lines AC BC, and produce them as the cafe requires; thefe lines will be perpendicular to the reflecting furface, and therefore the extremities of the image will fall upon them. Through F the middle point of the object and the centre, draw the line FC, and produce it till it paffes through the reflecting furface; this will alfo be perpendicular to the furface. Through G, the point where this line cuts the furface, draw the lines AG and BG, and produce them this way or that, till they crofs the former perpendiculars; and where they crofs, there I and M the extremities of the image will fall. For fuppofing AG to be a ray proceeding from the point A and falling upon G, it will be reflected to B; becaufe FA is equal to FB, and FG is perpendicular to the reflecting furface; and therefore the reprefention of the point A will be in BG produced as well as in AC; confequently it will fall on the point I, where they crofs each other. Likewife the ray BG will for the fame reafon be reflected to A; and therefore the reprefentation of the point B will be in AG produced as well as in fome part of BC, that is, in M where they crofs. From whence the propofition is clear.

If it happens that the lines will not crofs which way foever they are produced, as in fig. 20. then is the object in the focus of parallel rays of that furface, and has no image formed in any place whatever. For in this cafe the rays AH, AG, flowing from the point A, become parallel after reflection in the lines HC, GB, and therefore do not flow as to or from any point: in like manner, rays flowing from B are reflected into the parallel lines KB and GA; fo that no reprefentation can be formed by fuch reflection.

From hence we learn another circumftance relating to the magnitude of the image made by reflection; viz. that it fubtends the fame angle at the vertex of the reflecting furface that the object does. This appears by infpection of the 17th, 18th, or 19th figure, in each of which the angle IGM, which the image fubtends at G the vertex of the reflecting furface, is equal to the angle AGB, which the object fubtends at the fame place; for in the two firft of thofe figures they are vertical, in the third they are the fame. And,

Farther, the angle ICM, which the image fubtends at the centre, is alfo equal to the angle ACB which the object fubtends at the fame place; for in the two firft figures they are the fame, in the laft they are vertical to each other.

From whence it is evident, that the object and its image are to each other in diameter, either as their refpective diftances from the vertex of the reflecting furface, or as their diftances from the centre of the fame.

IV. As objects are multiplied by being feen thro' tranfparent media, whofe furfaces are properly difpofed, fo they may alfo by reflecting furfaces. Thus,

Different Refrangibility of Light.

1. If two reflecting furfaces be difpofed at right angles, as the furfaces AB, BC, (fig. 21.), an object at D may be feen by an eye at E, after one reflection at F, in the line EF produced; after two reflections, the firft at G, the fecond at H, in the line EH produced; and alfo, after one reflection made at A, in the line EA produced.

2. If the furfaces be parallel, as AB, CD, (fig. 22.), and the object be placed at E and the eye at F, the object will appear multiplied an infinite number of times: thus, it may be feen in the line FG produced, after one reflection at G; in the line FH produced, after two reflections, the firft at I, the fecond at H; and alfo in FP produced, after feveral fucceffive reflections of the ray EL, at the points L, M, N, O, and P: and fo on *in infinitum*. But the greater the number of reflections are, the weaker the reprefentation will be.

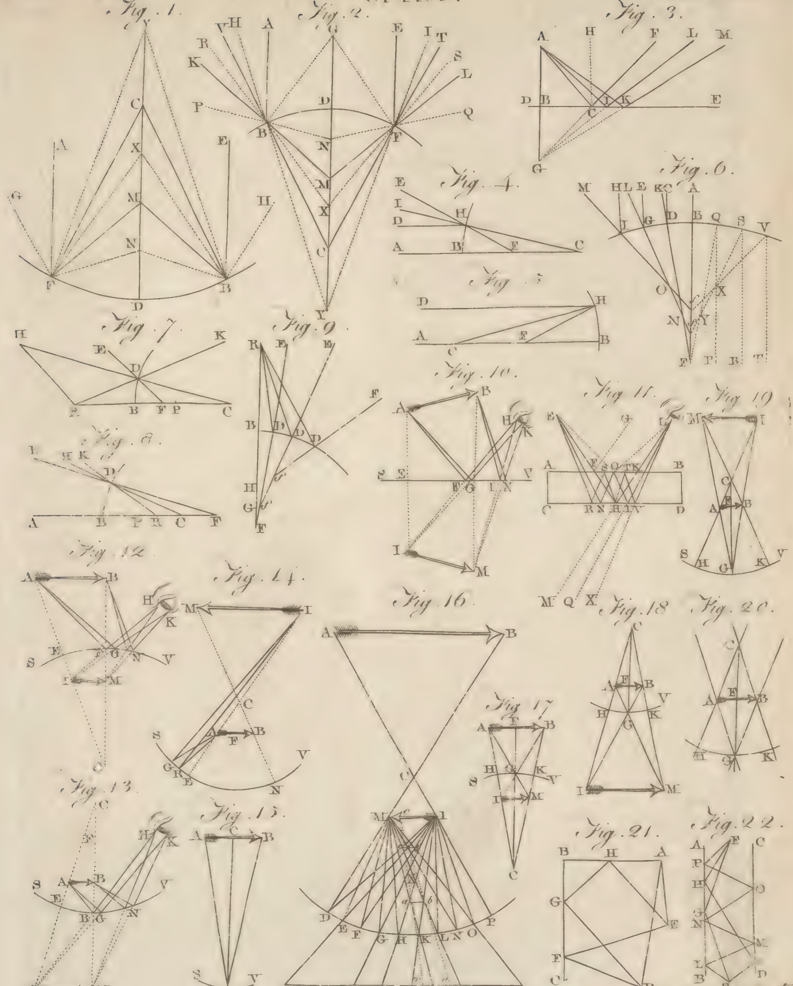
Sect. IV. *Of the different Refrangibility of Light.*

As this property of light folves a great number of the phenomena which could not be underftood by former opticians, we fhall give an account of it in the words of Sir Ifaac Newton, who firft difcovered it; efpecially as his account is much more full, clear, and perfpicuous, than thofe of fucceeding writers.

Plate CCXI. fig. 9.

"In a very dark chamber, at a round hole F, about one third of an inch broad, made in the fhut of a window, I placed a glafs prifm ABC, whereby the beam of the fun's light, SF, which came in at that hole, might be refracted upwards, toward the oppofite wall of the chamber, and there form a coloured image of the fun, reprefented at PT. The axis of the prifm, (that is, the line paffing thro' the middle of the prifm, from one end of it to the other end, parallel to the edge of the refracting angle) was in this and the following experiments perpendicular to the incident rays. About this axis I turned the prifm flowly, and faw the refracted light on the wall, or coloured image of the fun, firft to defcend, and then to afcend. Between the defcent and afcent when the image feemed ftationary, I ftopped the prifm and fixed it in that pofture.

"Then I let the refracted light fall perpedicularly upon a fheet of white paper, MN, placed at the oppofite wall of the chamber, and obferved the figure and dimenfions of the folar image, PT, formed on the paper by that light. This image was oblong and not oval, but terminated by two rectilinear and parallel fides and two femicircular ends. On its fides it was bounded pretty diftinctly; but on its ends very confufedly and indiftinctly, the light there decaying and vanifhing by degrees. At the diftance of $18\frac{1}{2}$ feet from the prifm the breadth of the image was about $2\frac{1}{8}$ inches, but its length was about $10\frac{1}{4}$ inches, and the length of its rectilinear fides about eight inches; and ACB, the refracting angle of the prifm, whereby fo great a length was made, was 64 degrees. With a lefs angle the length of the image was lefs, the breadth remaining the fame. It is farther to be obferved, that the rays went on in ftraight lines from the prifm to the image, and



A Bell Sculp.t

Different Refrangibility of Light.

and therefore at their going out of the prism had all that inclination to one another from which the length of the image proceeded. This image PT was coloured, and the more eminent colours lay in this order from the bottom at T to the top at P; red, orange, yellow, green, blue, indigo, violet; together with all their intermediate degrees in a continual succession perpetually varying."

Our author concludes from this experiment, and many more to be mentioned hereafter, "that the light of the sun consists of a mixture of several sorts of coloured rays, some of which at equal incidences are more refracted than others, and therefore are called *more refrangible.* The red at T, being nearest to the place Y, where the rays of the sun would go directly if the prism was taken away, is the least refracted of all the rays; and the orange, yellow, green, blue, indigo, and violet, are continually more and more refracted, as they are more and more diverted from the course of the direct light. For by mathematical reasoning he has proved, that when the prism is fixed in the posture above-mentioned, so that the place of the image shall be the lowest possible, or at the limit between its descent and ascent, the figure of the image ought then to be round like the spot at Y, if all the rays that tended to it were equally refracted. Therefore, seeing by experience it is found that this image is not round, but about five times longer than broad, it follows that all the rays are not equally refracted. And this conclusion is farther confirmed by the following experiments.

Plate CCXI. fig. 10.

"In the sun-beam SF, which was propagated into the room thro' the hole in the window-shut EG, at the distance of some feet from the hole, I held the prism ABC in such a posture, that its axis might be perpendicular to that beam: then I looked thro' the prism upon the hole F, and turning the prism to and fro about its axis to make the image *pt* of the hole ascend and descend, when between its two contrary motions it seemed stationary, I stopped the prism; in this situation of the prism, viewing through it the said hole F, I observed the length of its refracted image *pt* to be many times greater than its breadth; and that the most refracted part thereof appeared violet at *p*; the least refracted red, at *t*; and the middle parts indigo, blue, green, yellow, and orange, in order. The same thing happened when I removed the prism out of the sun's light, and looked through it upon the hole shining by the light of the clouds beyond it. And yet if the refractions of all the rays were equal according to one certain proportion of the sines of incidence and refraction, as is vulgarly supposed, the refracted image ought to have appeared round, by the mathematical demonstration above-mentioned. So then by these two experiments it appears, that in equal incidences there is a considerable inequality of refractions."

For the discovery of this fundamental property of light, which has opened the whole mystery of colours, we see our author was not only beholden to the experiments themselves, which many others had made before him, but also to his skill in geometry; which was absolutely necessary to determine what the figure of the refracted image ought to be upon the old principle of an equal refraction of all the rays: but having thus made the discovery, he contrived the following experiment to prove it at sight.

Different Refrangibility of Light.

"In the middle of two thin boards, DE, *de*, I made a round hole in each, at G and *g*, a third part of an inch in diameter; and in the window-shut a much larger hole being made, at F, to let into my darkened chamber a large beam of the sun's light, I placed a prism, ABC, behind the shut in that beam, to refract it towards the opposite wall; and close behind this prism I fixed one of the boards DE, in such a manner that the middle of the refracted light might pass through the hole made in it at G, and the rest be intercepted by the board. Then at the distance of about 12 feet from the first board, I fixed the other board, *de*, in such manner that the middle of the refracted light, which came through the hole in the first board, and fell upon the opposite wall, might pass through the hole *g* in this other board *de*, and the rest being intercepted by the board, might paint upon it the coloured spectrum of the sun. And close behind this board I fixed another prism *abc*, to refract the light which came through the hole *g*. Then I returned speedily to the first prism ABC, and by turning it slowly to and fro about its axis, I caused the image which fell upon the second board *de*, to move up and down upon that board, that all its parts might pass successively through the hole in that board, and fall upon the prism behind it. And in the mean time I noted the places, *M*, *N*, on the opposite wall, to which that light after its refraction in the second prism did pass; and by the difference of the places at *M* and *N*, I found that the light, which being most refracted in the first prism ABC, did go to the blue end of the image, was again more refracted by the second prism *abc*, than the light which went to the red end of that image. For when the lower part of the light which fell upon the second board *de*, was cast through the hole *g*, it went to a lower place M on the wall; and when the higher part of that light was cast through the same hole *g*, it went to a higher place, N, on the wall; and when any intermediate part of the light was cast through that hole, it went to some place in the wall between M and N. The unchanged position of the holes in the boards made the incidence of the rays upon the second prism to be the same in all cases. And yet in that common incidence some of the rays were more refracted and others less: and those were more refracted in this prism, which by a greater refraction in the first prism were more turned out of their way; and therefore, for their constancy of being more refracted, are deservedly called *more refrangible.*"

Plate CCXI. fig. 11.

Our author shews also, by experiments made with a convex glass, that lights (reflected from natural bodies) which differ in colour, differ also in degrees of refrangibility: and that they differ in the same manner as the rays of the sun do.

"The sun's light consists of rays differing in reflexibility, and those rays are more reflexible than others which are more refrangible. A prism, ABC, whose two angles, at its base BC, were equal to one another and half right ones, and the third at A a right one, I placed in a beam FM of the sun's light, let into a dark chamber through a hole F one third part of an inch broad. And turning the prism slowly about its axis until the light which went through one of its angles

Fig. 12.

Different Refrangibility of Light.

angles ACB, and was refracted by it to G and H, began to be reflected into the line MN by its base BC, at which till then it went out of the glass; I observed that those rays, as MH, which had suffered the greatest refraction, were sooner reflected than the rest. To make it evident that the rays which vanished at H were reflected into the beam MN, I made this beam pass thro' another prism VXY, and being refracted by it to fall afterwards upon a sheet of white paper *pt* placed at some distance behind it, and there by that refraction to paint the usual colours at *pt*. Then causing the first prism to be turned about its axis according to the order of the letters ABC, I observed, that when those rays MH, which in this prism had suffered the greatest refraction, and appeared blue and violet, began to be totally reflected, the blue and violet light on the paper which was most refracted in the second prism received a sensible increase at *p*, above that of the red and yellow at *t*: and afterwards, when the rest of the light, which was green, yellow, and red, began to be totally reflected and vanished at G, the light of those colours at *t*, on the paper *pt*, received as great an increase as the violet and blue had received before. Which puts it past dispute, that those rays became first of all totally reflected at the base BC, which before at equal incidences with the rest upon the base BC had suffered the greatest refraction. I do not here take notice of any refractions made in the sides AC, AB, of the first prism, because the light enters almost perpendicularly at the first side, and goes out almost perpendicularly at the second; and therefore suffers none, or so little, that the angles of incidence at the base BC are not sensibly altered by it; especially if the angles of the prism at the base BC be each about 40 degrees. For the rays FM begin to be totally reflected when the angle CMF is about 50 degrees, and therefore they will then make a right angle of 90 degrees with AC.

" It appears also from experiments, that the beam of light MN, reflected by the base of the prism, being augmented first by the more refrangible rays and afterwards by the less refrangible, is composed of rays differently refrangible.

" The light whose rays are all alike refrangible, I call *simple homogeneal* and *similar;* and that whose rays are some more refrangible than others, I call *compound heterogeneal* and *dissimilar*. The former light I call *homogeneal*, not because I would affirm it so in all respects; but because the rays which agree in refrangibility agree at least in all their other properties which I consider in the following discourse.

" The colours of homogeneal lights I call *primary, homogeneal* and *simple;* and those of heterogeneal lights, *heterogeneal* and *compound*. For these are always compounded of homogeneal lights, as will appear in the following discourse.

" The homogeneal light and rays which appear red, or rather make objects appear so, I call *rubrific* or *red making;* those which make objects appear yellow, green, blue, and violet, I call *yellow-making, green-making, blue-making, violet-making;* and so the rest. And if at any time I speak of light and rays as coloured or endowed with colours, I would be understood to speak not philosophically and properly, but grosly, and according to such conceptions as vulgar people in seeing all these experiments would be apt to frame. For the rays, to speak properly, are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour. For as sound in a bell or musical string or other sounding body, is nothing but a trembling motion, and in the air nothing but that motion propagated from the object, and in the sensorium it is a sense of that motion under the form of sound; so colours in the object are nothing but a disposition to reflect this or that sort of rays more copiously than the rest: in rays they are nothing but their dispositions to propagate this or that motion into the sensorium; and in the sensorium they are sensations of those motions under the forms of colours.

" By the mathematical proposition above-mentioned, it is certain that the rays which are equally refrangible do fall upon a circle answering to the sun's apparent disk, which will also be proved by experiment by and by. Now let AG represent the circle which all the most refrangible rays, propagated from the whole disk of the sun, would illuminate and paint upon the opposite wall if they were alone; EL the circle, which all the least refrangible rays would in like manner illuminate if they were alone; BH, CI, DK, the circles which so many intermediate sorts would paint upon the wall, if they were singly propagated from the sun in successive order, the rest being intercepted; and conceive that there are other circles without number, which innumerable other intermediate sorts of rays would successively paint upon the wall, if the sun should successively emit every sort apart. And seeing the sun emits all these sorts at once, they must all together illuminate and paint innumerable equal circles; of all which, being according to their degrees of refrangibility placed in order in a continual series, that oblong spectrum PT is composed, which was described in the first experiment.

Plate CCXI. fig. 13.

" Now if these circles, whilst their centres keep their distances and positions, could be made less in diameter, their interfering one with another, and consequently the mixture of the heterogeneous rays, would be proportionably diminished. Let the circles AG, BH, CI, &c. remain as before; and let *ag, bh, ci,* &c. be so many less circles lying in a like continual series, between two parallel right lines *ae* and *gl*, with the same distances between their centres, and illuminated with the same sorts of rays: that is, the circle *ag* with the same sort by which the corresponding circle AG was illuminated; and the rest of the circles *bh, ci, dk, el* respectively with the same sorts of rays by which the corresponding circles BH, CI, DK, EL, were illuminated. In the figure PT composed of the great circles, three of those, AG, BH, CI, are so expanded into each other, that three sorts of rays, by which those circles are illuminated, together with innumerable other sorts of intermediate rays, are mixed at QR in the middle of the circle BH. And the like mixture happens throughout almost the whole length of the figure PT. But in the figure *pt*, composed of the less circles, the three less circles *ag, bh, ci,* which answer to those three greater, do not extend into one another; nor are there any where mingled so much as any two of the three sorts of rays by which those circles are illuminated, and which in the figure PT are all of them intermingled at QR. So then, if we would diminish the mixture

Different Refrangibility of Light.

mixture of the rays, we are to diminiſh the diameters of the circles. Now theſe would be diminiſhed if the ſun's diameter, to which they anſwer, could be made leſs than it is, or (which comes to the ſame purpoſe) if without doors, at a great diſtance from the priſm towards the ſun, ſome opaque body were placed with a round hole in the middle of it to intercept all the ſun's light, except ſo much as coming from the middle of his body could paſs through that hole to the priſm. For ſo the circles AG, BH, and the reſt, would not any longer anſwer to the whole diſk of the ſun, but only to that part of it which could be ſeen from the priſm through that hole; that is, to the apparent magnitude of that hole viewed from the priſm. But that theſe circles may anſwer more diſtinctly to that hole, a lens is to be placed by the priſm to caſt the image of the hole (that is, every one of the circles AG, BH, &c.) diſtinctly upon the paper at PT; after ſuch a manner, as by a lens placed at a window the pictures of objects abroad are caſt diſtinctly upon a paper within the room. If this be done, it will not be neceſſary to place that hole very far off, no not beyond the window. And therefore, inſtead of that hole, I uſed the hole in the window-ſhut as follows.

Plate CCXI. fig. 14.

"In the ſun's light let into my darkened chamber through a ſmall round hole in my window-ſhut, at about 10 or 12 feet from the window, I placed a lens MN, by which the image of the hole F might be diſtinctly caſt upon a ſheet of white paper placed at I. Then immediately after the lens I placed a priſm ABC, by which the trajected light might be refracted either upwards or ſideways, and thereby the round image which the lens alone did caſt upon the paper at I, might be drawn out into a long one with parallel ſides, as repreſented at *pt*. This oblong image I let fall upon another paper at about the ſame diſtance from the priſm as the image at I, moving the paper either towards the priſm or from it, until I found the juſt diſtance where the rectilinear ſides of the image *pt* become moſt diſtinct. For in this caſe the circular images of the hole, which compoſe that image, after the manner that the circles *ag*, *bh*, *ci*, &c. do the figure *pt*, were terminated moſt diſtinctly, and therefore extended into one another the leaſt that they could, and by conſequence the mixture of the heterogeneous rays was now the leaſt of all. The cirlces *ag*, *bh*, *ci*, &c. which compoſe the image *pt*, are each equal to the circle at I; and therefore, by diminiſhing the hole F, or by removing the lens farther from it, may be diminiſhed at pleaſure, whilſt their centres keep the ſame diſtances from each other. Thus, by diminiſhing the breadth of the image *pt*, the circles of heterogeneal rays that compoſe it may be ſeparated from each other as much as you pleaſe. Yet inſtead of the circular hole F, it is better to ſubſtitute an oblong hole ſhaped like a parallelogram with its length parallel to the length of the priſm. For if this hole be an inch or two long, and but a 10th or 20th part of an inch broad, or narrower, the light of the image *pt* will be as ſimple as before, or ſimpler; and the image being much broader, is therefore fitter to have experiments tried in its light than before.

"Homogeneal light is refracted regularly without any dilatation, ſplitting, or ſhattering of the rays; and the confuſed viſion of objects ſeen through refracting bodies by heterogeneal light, ariſes from the different refrangibility of ſeveral ſorts of rays. This will appear by the experiments which will follow. In the middle of a black paper I made a round hole about a fifth or a ſixth part of an inch in diameter. Upon this paper I cauſed the ſpectrum of homogeneal light, deſcribed in the former article, ſo to fall that ſome part of the light might paſs through the hole in the paper. This tranſmitted part of the light I refracted with a priſm placed behind the paper; and, letting this refracted light fall perpendicularly upon a white paper, two or three feet diſtant from the priſm, I found that the ſpectrum formed on the paper by this light was not oblong, as when it is made in the firſt experiment, by refracting the ſun's compound light, but was, ſo far as I could judge by my eye, perfectly circular, the length being nowhere greater than the breadth; which ſhews that this light is refracted regularly without any dilatation of the rays, and is an ocular demonſtration of the mathematical propoſition mentioned above.

"In the homogeneal light I placed a paper circle of a quarter of an inch in diameter; and in the ſun's unrefracted, heterogeneal, white light, I placed another paper circle of the ſame bigneſs; and going from theſe papers to the diſtance of ſome feet, I viewed both circles through a priſm. The circle illuminated by the ſun's heterogeneal light appeared very oblong, as in the ſecond experiment, the length being many times greater than the breadth. But the other circle illuminated with homogeneal light appeared circular, and diſtinctly defined, as when it is viewed by the naked eye; which proves the whole propoſition mentioned in the beginning of this article.

"In the homogeneal light I placed flies and ſuch like minute objects, and viewing them through a priſm I ſaw their parts as diſtinctly defined as if I had viewed them with the naked eye. The ſame objects placed in the ſun's unrefracted heterogeneal light, which was white, I viewed alſo through a priſm, and ſaw them moſt confuſedly defined, ſo that I could not diſtinguiſh their ſmaller parts from one another. I placed alſo the letters of a ſmall print one while in the homogeneal light, and then in the heterogeneal; and viewing them through a priſm, they appeared in the latter caſe ſo confuſed and indiſtinct that I could not read them; but in the former, they appeared ſo diſtinct that I could read readily, and thought I ſaw them as diſtinct as when I viewed them with my naked eye; in both caſes, I viewed the ſame objects through the ſame priſm, at the ſame diſtance from me, and in the ſame ſituation. There was no difference but in the lights by which the objects were illuminated, and which in one caſe was ſimple, in the other compound; and therefore the diſtinct viſion in the former caſe, and confuſed in the latter, could ariſe from nothing elſe than from that difference in the lights. Which proves the whole propoſition.

"In theſe three experiments, it is farther very remarkable, that the colour of homogeneal light was never changed by the refraction. And as theſe colours were not changed by refractions, ſo neither were they by reflections. For all white, grey, red, yellow, green, blue, violet bodies, as paper, aſhes, red lead, orpiment, indigo, bice, gold, ſilver, copper, graſs, blue flowers, violets, bubbles of water tinged with various colours,

Different Refrangibility of Light.

colours, peacocks feathers, the tincture of lignum nephriticum, and such like, in red homogeneal light appeared totally red, in blue light totally blue, in green light totally green, and so of other colours. In the homogeneal light of any colour they all appeared totally of that same colour; with this only difference, that some of them reflected that light more strongly, others more faintly. I never yet found any body which by reflecting homogeneal light could sensibly change its colour.

"From all which it is manifest, that if the sun's light consisted of but one sort of rays, there would be but one colour in the world, nor would it be possible to produce any new colour by reflections and refractions, and by consequence, that the variety of colours depends upon the composition of light.

"The solar image *pt*, formed by the separated rays in the 5th experiment, did in the progress from its end *p*, on which the most refrangible rays fell, unto its end *t*, on which the least refrangible rays fell, appear tinged with this series of colours; violet, indigo, blue, green, yellow, orange, red, together with all their intermediate degrees in a continual succession perpetually varying; so that there appeared as many degrees of colours as there were sorts of rays differing in refrangibility. And since these colours could not be changed by refractions nor by reflections, it follows, that all homogeneal light has its proper colour answering to its degree of refrangibility.

"Every homogeneal ray considered apart is refracted, according to one and the same rule; so that its sine of incidence is to its sine of refraction in a given ratio: that is, every different coloured ray has a different ratio belonging to it. This our author has proved by experiment, and by other experiments has determined by what numbers those given ratios are expressed. For instance, if an heterogeneal white ray of the sun emerges out of glass into air; or, which is the same thing, if rays of all colours be supposed to succeed one another in the same line AC, and AD their common sine of incidence in glass be divided into 50 equal parts, then EF and GH, the sines of refraction into air, of the least and most refrangible rays, will be 77 and 78 such parts respectively. And since every colour has several degrees, the sines of refraction of all the degrees of red will have all intermediate degrees of magnitude from 77 to $77\frac{1}{8}$, of all the degrees of orange from $77\frac{1}{8}$ to $77\frac{1}{5}$, of yellow from $77\frac{1}{5}$ to $77\frac{1}{3}$, of green from $77\frac{1}{3}$ to $77\frac{1}{2}$, of blue from $77\frac{1}{2}$ to $77\frac{2}{3}$, of indigo from $77\frac{2}{3}$ to $77\frac{7}{9}$, and of violet from $77\frac{7}{9}$ to 78.

Plate CCXI. fig. 15.

PART III.

END OF THE SEVENTH VOLUME.

DIRECTIONS for placing the PLATES in this VOLUME.

Number of Plates.				Number of Plates.			
192, or Plate	CLXXV.	To face	Page 4991	211, or Plate	CXCIV.	To face *Music*, p. (21.)	
193	CLXXVI.	- -	4994	212	CXCV.		
194	CLXXVII.	- -	4996	213	CXCVI.	- -	5316
195	CLXXVIII.	- -	5037	214	CXCVII.	- -	5318
196	CLXXIX.	- -	5038	215	CXCVIII.	- -	5320
197	CLXXX.	- -	5039	216	CXCIX.	- -	5322
198	CLXXXI.	- -	5065	217	CC.	- -	5323
199	CLXXXII.	- -	5231	218	CCI.	- -	5335
200	CLXXXIII.	- -	5253	229	CCII.	- -	5337
201	CLXXXIV.	- -	5254	220	CCIII.	- -	5347
202	CLXXXV.	- -	5262	221	CCIV.	- -	5373
203	CLXXXVI.	To face *Music*, p. (21.)		222	CCV.	- -	5456
204	CLXXXVII.			223	CCVI.	- -	5487
205	CLXXXVIII.			224	CCVII.	- -	5499
206	CLXXXIX.			225	CCVIII.	- -	5512
207	CXC.			226	CCIX.	- -	5528
208	CXCI.			227	CCX.	- -	5538
209	CXCII.			228	CCXI.	- -	5544
210	CXCIII.			229	CCXII.	- -	5554

N. B. ERRATA, OMISSIONS, &c. noticed and supplied in the APPENDIX at the end of the Work.